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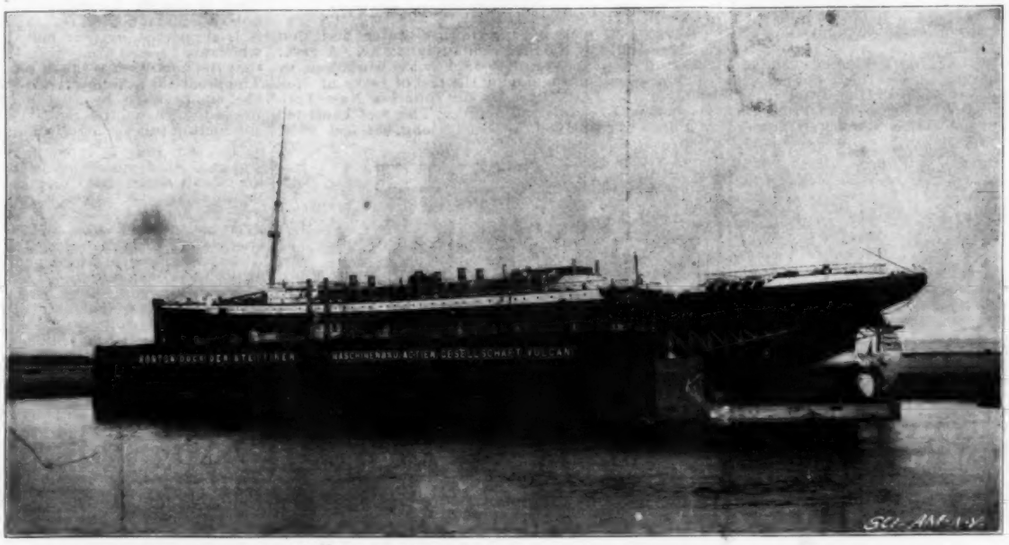
A PROBLEM IN SHIPBUILDING.

UPON the dock of the Vulcan Company, of Stettin, a most interesting and important work is being done, the probable success of which can be characterized as epoch-making in shipbuilding. As everyone knows, large ocean-steamers are nowadays built as twin screw ships. Such vessels, with their two independent sets of engines, can be driven by more powerful machinery, are enabled to make better time, are more easily controlled and for that reason are in many respects far safer than ordinary single screw steamers. The large steamship-companies who are engaged in the carrying of passengers are now confronted with the question, whether it is possible to transform the present single screw steamers (in themselves very excellent vessels, but as single screw steamers no longer quite modern) into twin screw ships of the newest type.

This is a problem which has for some time engaged the attention of large shipbuilding docks. The shipbuilder is concerned not so much with the difficulty of the task, which, grave though it be, can be overcome in the present advanced stage of mechanics, but with the question whether so extensive a rebuilding is worth the trouble, whether the speed of the vessel after having been rebuilt will be increased. No steamship company has, up to the present, been bold enough to undertake so huge and so entirely new a project. The North German Lloyd Company has, however, authorized the Vulcan Company to lengthen and to transform into a twin screw steamer one of its large single screw vessels.

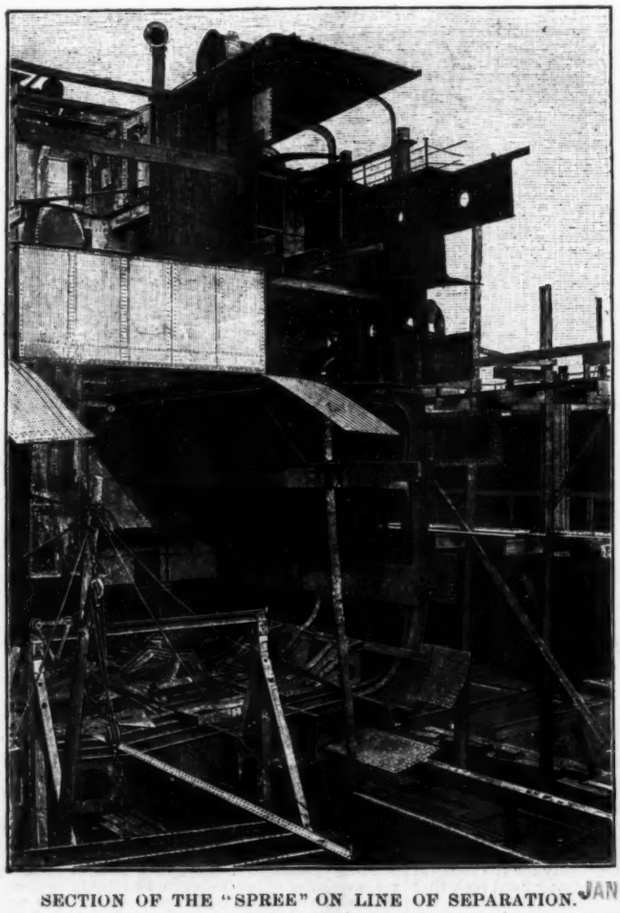
Let us glance at the details of this interesting work. The old engines and boilers of the steamer were removed; the vessel was floated into the large pontoon-dock and lifted clear of the water and shored, so that her huge hull could be reached from all sides. The enormous keel was supported by keel-blocks. The ship was to be lengthened 20 meters, and, therefore, 20 new ribs spaced one meter apart had to be inserted. That is all simple enough; but in order to insert the new framing, the hull had to be pulled apart 20 meters, and this pulling apart constituted the first part of the work to be done.

For this purpose, in the middle of the hull, at the portion where the vessel was to be divided,

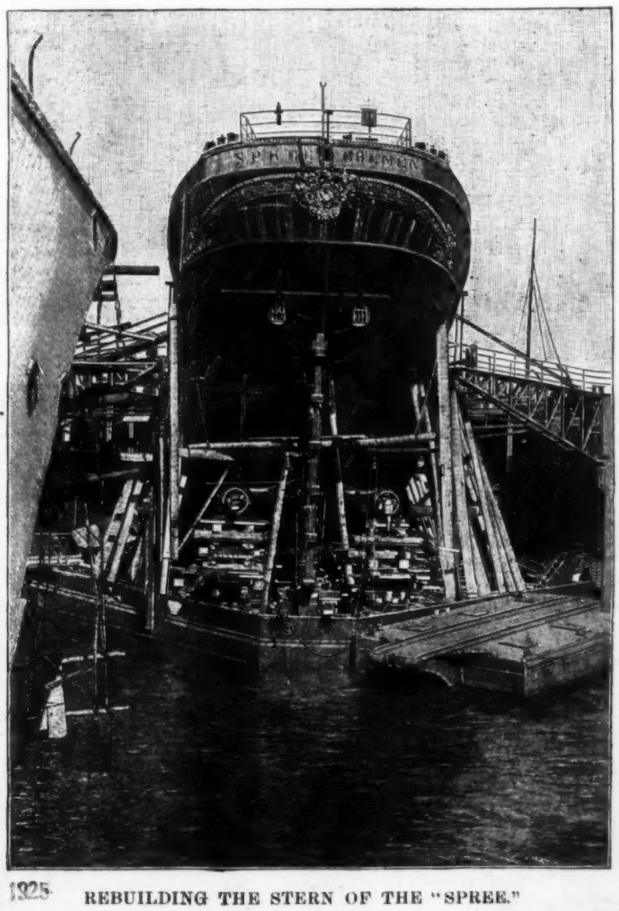


STETTIN FLOATING DRYDOCK, CARRYING THE NORTH GERMAN LLOYD STEAMER "SPREE."

Dimensions of Dock: Length, 510 feet; extreme breadth, 110 feet 9 inches; height, 48 feet 7 inches. Lifting power, 12,000 tons.



SECTION OF THE "SPREE" ON LINE OF SEPARATION.



REBUILDING THE STERN OF THE "SPREE."

THE LENGTHENING AND REBUILDING OF AN OCEAN LINER.

JAN 22 1925

all the rivet-heads were filed off; the rivets knocked out of the plates and the ribs; and the parts of the keel disconnected. That half of the ship which was to be hauled forward 20 meters weighed 3,000 tons. The hauling apart was accomplished by means of two hydraulic cylinders fitted with pistons, one cylinder being placed at each side of the cradle. From the hydraulic pistons there extended from each side two lengths of chain, which were secured to the cradle. Upon each pull of the chain the ship was pulled apart 2 meters. At first eight minutes were required to separate the parts 2 meters; but the initial velocity gradually increased, because the coefficient of friction, as the enormous load was pulled further asunder, became so great that toward the last a pull of 2 meters consumed fifteen minutes. When the pistons had completed their stroke of 2 meters, a section of chain 2 meters long was pulled in; the pistons then returned and made another stroke, and in this manner the sections of the hull were separated.

The various sections of the dock had always to be kept on the same level, and hence, careful observations had to be made as the ship was hauled forward, in order to determine how much the front portion of the dock sank under the increasing load. The surplus load was compensated for by removing the water in the dock with the aid of electrical, centrifugal pumps.

After all preparations had been made the hauling apart began at eight o'clock. At five o'clock in the afternoon, the two halves of the ship had been pulled asunder 20 meters; the work was hence completed in about five hours, and the insertion of twenty new ribs could then be undertaken.

The first part of the rebuilding having been successfully accomplished, we may cherish the hope that the second part—the transformation of the vessel into a twin screw ship—may also be successful. True it is, that the second part of the work comprehends far more extensive changes than the first, and will require some months.

In place of the old single engine, the ship will now receive two entirely independent engines of the most improved construction, each being placed in a water-tight compartment. The engines will be of the four-cylinder, triple expansion type, receiving their steam from thirteen boilers working at a pressure of 165 pounds to the square inch. Nine of the boilers are double-ended. Both engines will have 16,000 indicated horse power, and will probably give the ship a speed of twenty knots. Each engine drives its own screw by means of a nickel-steel shaft.

In steamers of great engine-power and speed much depends upon the shaft-bearings; for the propellers make many revolutions per minute and hence produce considerable vibration.

The placing of the two shafts with their bearings necessitates the removal and rebuilding of the stern of the ship. What this means, only a man familiar with shipbuilding can comprehend. To rebuild the vessel in such a manner is far more difficult than to construct an entirely new hull.

After having been lengthened, the ship will be 540 feet long; her new, capacious bunkers will contain 2,800 tons of coal; and by means of numerous longitudinal and lateral bulkheads, she will be divided into many water-tight compartments. The doors of these bulkheads in case of danger can be closed in a few seconds by electrical apparatus.

This apparatus is entirely new and has been used only on the North German Lloyd steamer "Kaiser Wilhelm der Grosse." Should a collision occur, a single movement of an electric switch would telegraph to all parts of the ship the order, "Clear the bulkheads!" And no one would then be allowed to pass through the doors. Several seconds later a second movement of the switch would cause the air-tight, wedge-shaped doors to rush down like a flash of lightning, and divide the ship into a large number of water-tight, floating parts. Water-tight bulkheads have long been employed on ocean-steamers; but they have unfortunately not been numerous enough, nor have they been provided with a sufficiently rapid means of closing the doors.

The large floating dock in which the steamer rests must now be briefly described. The dock is one of the largest of its kind. It has a total length of 510 feet, an extreme breadth of 110 feet 9 inches, and a height of 43 feet 7 inches, measured from the bottom of the pontoon to the top of the walls. Between the two side walls are connected three pontoons, that at the center being 240 feet long, and those at the two ends 135 feet. The internal width is sufficient to allow vessels of 83 feet beam to be docked. The maximum lifting power is 12,000 tons. The entire dock is divided into thirty-eight water-tight compartments, each emptied or filled by separate valves. Within each of the side walls are contained two compound engines of 125 horse power each, and the boilers belonging thereto. Each engine drives two 15-inch centrifugal pumps. With this powerful machinery it is possible to lift a ship of 11,000 tons displacement clear of the water in about two and a half hours.—Illustrirte Zeitung.

ROCK BLASTING UNDER WATER.

EXTENSIVE rock blasting under water was first made possible by the invention of dynamite. A great sensation was caused in 1869–1876 by the work done by General Newton in removing the reef of rocks at Hell Gate, in the East River, which connects New York Harbor with Long Island Sound. This reef consisted of a mass of rock about 1,968 feet long, 984 feet wide, and was covered by an average of 6 feet to 9 feet of water, which was to be deepened to about 26 feet. The rock was honeycombed by about 4,855 feet of radial and 5,839 feet of concentric galleries, which varied in width from 11 feet to 17 feet, and were about 14 feet 9 inches high. The average thickness of the roof left was 9 feet. It took seven years to blast out these galleries. At first the work was done by hand, but later by steam-driven machines. In this way 46,944 cubic yards of stone were detached and carried out, while the mass left in the pillars and roof amounted to about 31,296 cubic yards, which was blasted away on the 24th of September, 1876, by means of 4,000 mines that were exploded simultaneously by electricity. Before blasting the galleries were filled with water. The vibration caused by the explosion was perceptible in the water only for a distance of about 1,640 feet, but the water was thrown to a height of about 65 feet and the mass of water thrown up was about 295 feet in diameter.

Where an isolated block of stone under water is to be removed, it is broken to pieces by means of dynamite cartridges and the debris is raised by divers or by using grippers. In certain cases a rock has been surrounded by a wall of piles or beton and then removed dry. Rock is sometimes destroyed without previous drilling by simply placing dynamite cartridges on it. In such cases the rock is broken in slabs and the fragments are carried away by the current or are raised by dredges. Since the introduction of bucket chain dredges these have been used not only for the removal of broken pieces, but also for removing hard rock that is formed in nearly horizontal strata (even when the stone is 15 inches thick) alternating with strata of soft material. In this way the banks of limestone alternating with strata of clay were removed from the harbor of Boulogne-sur-Mer.

Sometimes rocks are broken up by heavy rams provided with iron points or by machine-operated chisels. The latter method was used in the construction of the Suez Canal and also in the work on the cataracts of the Danube, where three apparatus of this kind were used. Such an apparatus consists of a large, heavy iron chisel, which, with the necessary machinery, is placed in the center of a boat built specially for it. The machinery may be divided into two essential parts, the tripod frame on which the chisel is raised to the water level by means of lifting devices and the arrangement for moving the boat forward, backward, or sidewise. The operation is very simple. The boat is anchored by one chain from the bow, four from the sides and one from the stern, and after the rock has been destroyed for a distance of about half a yard, the boat is moved forward a corresponding distance by pulling on the chain at the bow, and then work is begun anew. The debris is removed by means of dredges.

During the operations on the Danube in 1893, 42,510 cubic yards of stone were loosened by 823,000 blows of the chisels in 521 working days. Each apparatus destroyed 81·5 cubic yards per day, or 0·05 cubic yard at each blow. Besides these apparatus seven floating drilling machines were employed in breaking the rock in the Danube, such as had already been tested on the Rhine, and later in blasting out a canal 19 feet 8 inches deep in the St. Lawrence River near Montreal. In order to hold a boat in the rapid current of the river it is supported by four movable pillars, the ends of which are pressed firmly into the bed of the river, so that the boat itself is raised somewhat from the water. The process is as follows: After a boat is in place and the chains have been stretched, the supports are pressed down on the rocky bed, the frame with the conducting tubes is let down on the bed of the river,

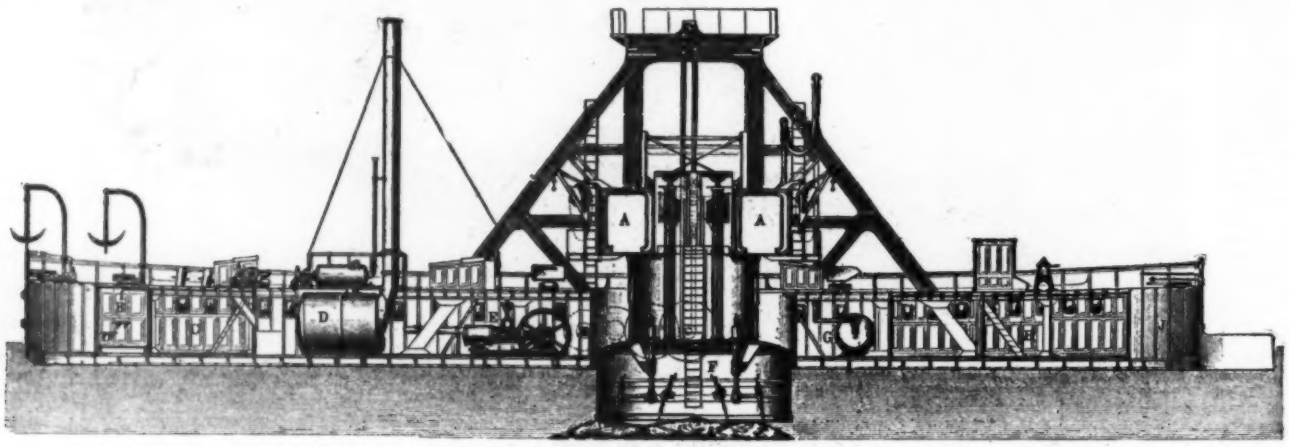


FIG. 1.—VERTICAL SECTION.

A, reception tanks; *B*, shower bath; *C*, sleeping room for workmen; *D*, steam boiler; *E*, air condenser; *F*, caisson; *G*, air reservoir; *H*, cabins; *I*, water ballast compartment.

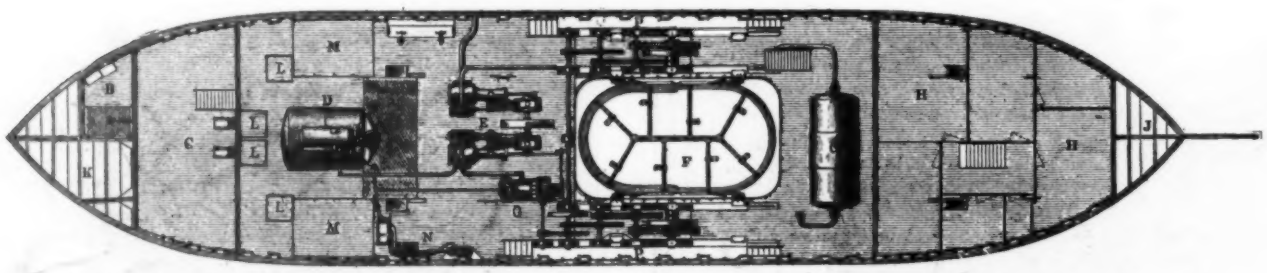


FIG. 2.—PLAN VIEW, SHOWING THE INTERIOR ARRANGEMENT OF THE BOAT AND OF THE LOWER PART OF THE SHAFT.

B, shower bath; *C*, sleeping room for workmen; *D*, steam boiler; *E*, air condenser; *F*, caisson; *G*, air reservoir; *H*, cabins; *I*, water ballast compartment; *K*, cable room; *L* chain boxes; *M*, coal bunkers; *N*, steam pump; *O*, apparatus for operating caisson windlass; *P*, caisson windlass.

ROCK BLASTING UNDER WATER—ONE OF THE SHAFTS USED IN THE WORK ON THE RHINE BOTTOM.

and the cross-shaped drills are secured to the rods, the upper ends of which are attached to the drilling machines. Then the operation of the drills, which are worked by steam, begins. At each stroke the drill is turned a little. After the holes have been bored a certain distance below the desired bottom of the river, they are washed out by a powerful jet of water, and then they are loaded with dynamite cartridges, which are provided with igniting cartridges or fuses, the upper ends of which are connected by wires with an electric igniter. After the holes have been charged the supports or feet are raised, the boat is moved aside by means of the anchor chains, and all the charges are exploded. The drill holes are two or three yards apart, and from six to twelve, or even, in some cases, from twelve to twenty-two can be drilled without moving the boat.

Each of the seven boats used in the work on the Danube carried from three to eleven drills, and all together they removed 298,616 cubic yards of rock. The entire mass of rock blasted under water in five years amounted to 387,000 cubic yards. The broken rock was removed by bucket dredges, scoop dredges, and crane dredges. A uniform bottom cannot be obtained by this kind of blasting, because of irregular ruptures caused by lack of uniformity in the quality of the stone, and, therefore, if it is desirable to have a level bottom, caissons or shafts like those shown in the accompanying engravings must be employed.

Shafts of this kind were used extensively in the blasting operations in the Rhine near Bingen. They are suspended either between two boats or from one boat which has been built specially for this purpose with a central opening. After such a boat has been anchored the caisson is let down to the bed of the river

and the water forced out by means of compressed air, which is also used for operating the drills. The holes are drilled about a yard below the desired level of the bottom. After the dynamite cartridges have been put in place the boat is pushed off to one side for a distance of about 130 to 160 feet, all the cartridges are exploded simultaneously by electricity; then the boat is brought back into position for blasting and the shaft is sunk again. The loosened rock can be removed either through the shaft, which is a comparatively slow operation, or can be removed later by means of dredges. The principal advantages of such a shaft consist in the facility thus offered for examining every part of the bottom and leveling it by hand where necessary, and in the ease with which the seat of operations can be changed without loss of time.

The latter advantage adapts the shaft especially for work on the Rhine, where the machinery has to be moved frequently to make room for the passage of floats and tows made up of a number of boats. Each of the shafts employed there covered a surface of about 27·5 square yards, in which, as a rule, fourteen to seventeen holes were drilled. The blasting operations extended over a surface of 49 square yards, so there was one hole for about each 2·7 square yards of blasting surface. On an average 360 feet of hole was drilled per day by one shaft. During the operations in the Rhine, near Bingen, about 260,000 cubic yards of stone were blasted out. Extensive blasting operations under the harbor of Genoa were carried on by means of specially constructed caissons and compressed air under the direction of Conradin Zschokke.

THE COX TYPE-SETTING MACHINE.

THE production of a satisfactory machine for composing type has long been a fascinating objective for inventors. The earlier attempts proved far from successful from a commercial point of view, but within recent years several excellent machines have been produced which are now largely used, in particular for newspaper work. The art of composing may, perhaps, be divided up into three different operations, viz., setting the type, justification, and distribution. The problem of effecting the first and third of these operations mechanically has long ceased to present any really formidable difficulties, but the matter of mechanical justification—that is, of so spacing the different lines that each line shall be completely filled—proved much less easy. Within recent years, however, several machines acting on different principles have been introduced which operate quite satisfactorily. Among the most original and ingenious of the devices adopted for this purpose must certainly be reckoned that employed in the Cox type-setting machine, which we illustrate, and which has been on view for some months past at the offices of the Cox Type-Setting Machine Company, 22 St. Bride Street, London, W. C. The idea will readily be grasped on a glance at Fig. 5, which represents three words separated by Cox's spaces. These spaces consist of corrugated pieces of lead ribbon, and the plan adopted is to always overset each line. This done, end pressure is applied and the length of the line adjusted by flattening the corrugations, as shown in Fig. 5, where it will be seen that the spaces have been squeezed nearly flat. In other cases the flattening is less, as shown by the samples illustrated in the figure. As we have said, the mere matter of setting and distributing type by machine has long ceased to present difficulties, and in the Cox machine the usual device of employing type nicked differently for each letter is employed. The types when in place on the setting machine rest in grooved rules which are placed on the machine in a nearly vertical position, as shown in Fig. 2, which represents a back view of the machine. The types tend to slide down the grooves by their own weight, but are prevented from falling out at the bottom by a plate on

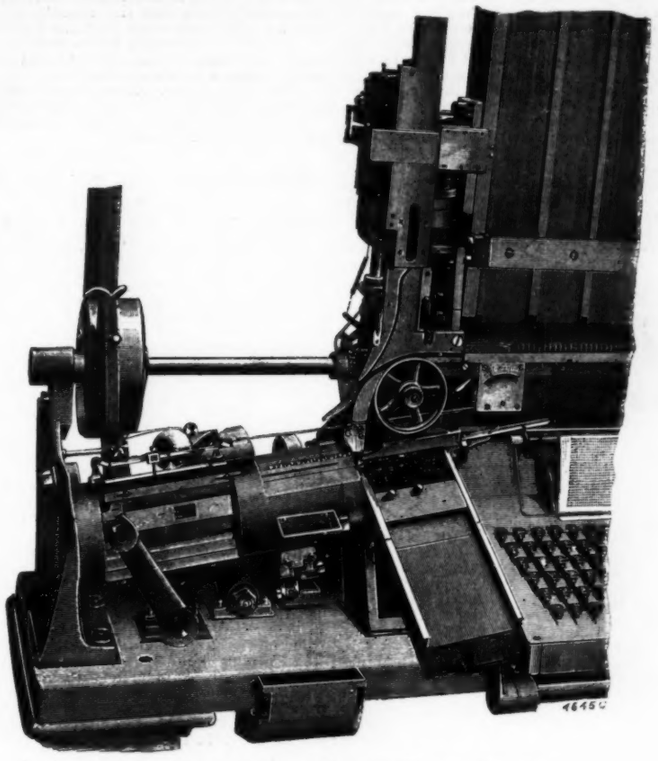


FIG. 3.—MECHANISM FOR PLACING TYPE IN GALLEY.

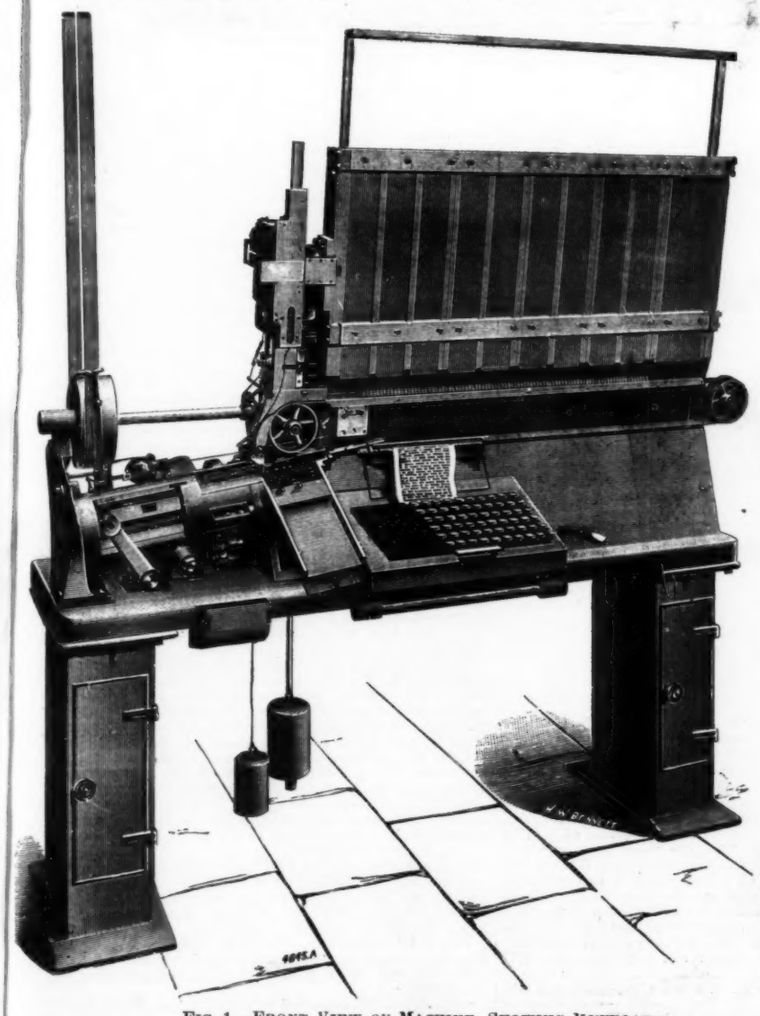


FIG. 1.—FRONT VIEW OF MACHINE, SHOWING KEYBOARD.

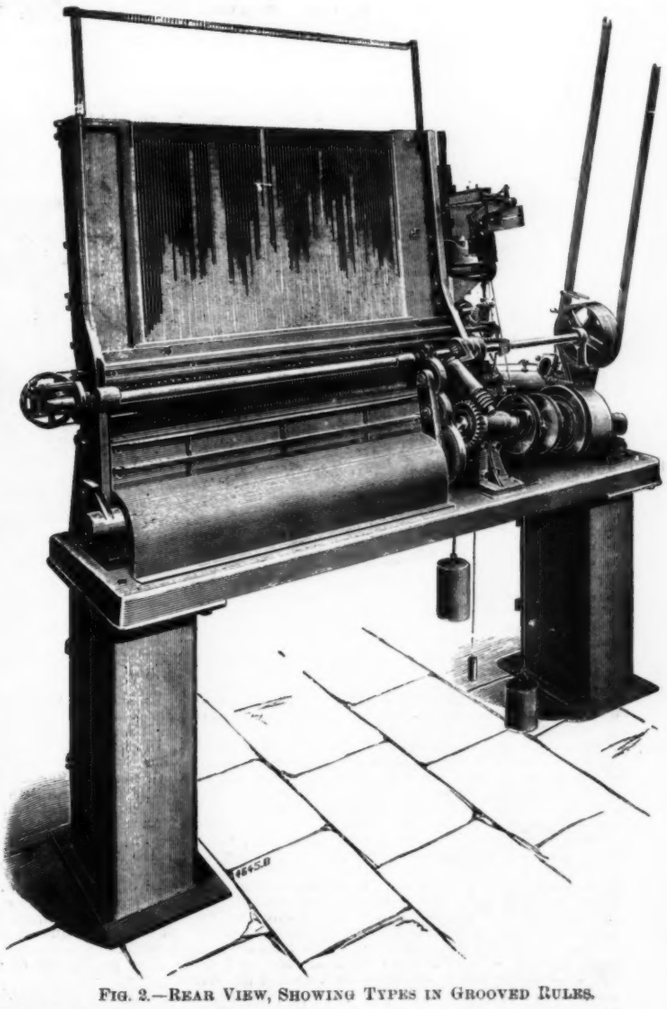


FIG. 2.—REAR VIEW, SHOWING TYPES IN GROOVED RULES.

THE COX TYPE-SETTING MACHINE.

which the lowest type rests. Opposite this type is a hole leading to the front of the machine, while behind it is a steel finger, which on depressing the proper key is moved forward, and ejects the type. The requisite power for this is not provided by the finger of the operator, but is obtained from a rapidly rotating shaft at the back of the machine. On the depression of a key, the finger corresponding thereto is kinematically coupled up with the shaft, and being moved forward thereby, ejects the type. The latter passes on to a rapidly moving copper belt, which can be seen in Fig. 1, passing over the two pulleys shown to the right and left of the type store. This belt delivers the type to a shoot, which is shown more clearly in Fig. 3. Down this shoot the type passes, being finally pushed forward into a groove cut in a cylinder. As the line of type fills up, an indicator shown a little above and to the left of the "copy," in Fig. 1, moves forward, showing the position of affairs as the end of the line is approached. The line must be so filled that this point passes one indicating mark and fails to pass a second. When full the

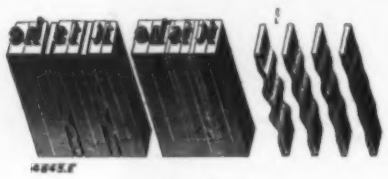


FIG. 5.

WORDS SEPARATED BY CORRUGATED LEAD RIBBONS.

handle shown to the right of the keyboard in Fig. 1 is depressed, which has the effect of throwing into gear the worm and worm wheel shown at the back of the machine in Fig. 2. This wormwheel is keyed to a shaft carrying various cams, which, in the course of a complete revolution, justify the line previously set by compressing the spaces, and deliver it on to the galley shown to the left of the keyboard; next they rotate the cylinder so as to bring a fresh groove into place to receive a new line, and finally, throw out of gear the worm and wheel, restoring the machine to its previous state. Should matter fail to fill out a line, the latter is made up not by the corrugated spaces, but by ordinary em quads set by a key the same way as the letters proper. The question of distribution is nearly as important as that of type setting, and in the Cox system is divided into two parts, in the first of which all spaces and leads are removed, leaving nothing but type to go on to the distributing machine proper. This space sorting machine is shown in Fig. 4. The matter to be distributed is transferred to the galley shown at the back and forced forward by the action of a heavy weight. The leads on reaching the front of this galley pass through a slot and are collected below. This slot is, however, too narrow for the type to pass, but each line, on reaching the front, is thrust to the left into a space in which the letters are held at top and bottom only. The spaces, being lower than the letters, are held at the bottom only, and hence are easily knocked out by a set of spring fingers, which are advanced against the line as it stands in this position. The separated spaces pass into the cylindrical cage shown below, which is kept constantly rotating. The wires of which this cage is composed are set too closely to allow the em quads to pass, but the corrugated spaces, being thinner, fall

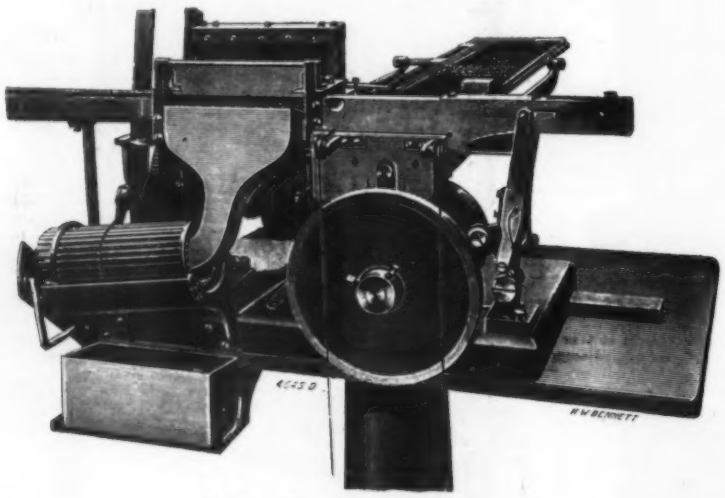


FIG. 4.—SPACE SORTING DEVICE.

THE COX TYPE-SETTING MACHINE.

through these openings, and are thus separated for remelting, while the em quads passing out of the end of the cage are collected for use again.

The type thus freed from spaces is pushed forward by the advent of a second line behind it, and finally delivered into a grooved rule, which, when full, is transferred bodily to the distributing machine. The latter consists of a drum rotating about a vertical axis to which the rules aforesaid and their type can be temporarily fixed in a vertical position. The type, therefore, then tends to descend by gravity. Set in a circle below these rules are a series of steel wards having different shapes for every letter. Suppose, for instance, the letter "w" to be the bottom letter occupying a particular rule. This "w" can only drop out when the revolution of the cylinder carries it over the corresponding "w" ward, the projections in which pass through the notches in the type. On arrival at this ward, the type falls down and is collected in a second grooved rule below, while another letter takes its place as the bottom type in that particular rule. This letter on coming opposite its corresponding ward drops through in a similar way, and is collected in a corresponding rule. When full these collecting rules are removed and empty ones substituted; the sorted type being finally transferred to the composing machine for renewed use. The makers claim that this machine is specially suitable for high class book work, as founders' type are used, which are generally better than can easily be obtained with such machines as the Linotype, where each letter is cast in a cold mould, thus giving rise to slight imperfections, which, immaterial in newspaper work, are distinct blemishes in higher class printing.

For our engravings and the foregoing particulars we are indebted to Engineering.

THE MINING AND MINTING OF GOLD AND SILVER.*

THE speaker said that as the increasing production of precious metals all over the world is attracting much attention, not only in the metallurgical world but from students of political economy, statesmen, and others, he thought that a few reminiscences of his early experiences, commencing nearly thirty years ago and covering the period in which occurred the beginning of the greatest development of silver mining in this country, might prove interesting at the present time.

In 1869, the year in which the speaker entered the assay laboratory of the Mint as an assistant, the output of silver in the United States amounted in coining value to $12,000,000; in 1870 to $16,000,000; in 1871 to $23,000,000; in 1872 to $28,750,000.

In 1873, the year in which the "trade dollar" was created by act of Congress, the production of silver amounted to $35,750,000.

In 1878, the year in which the Bland bill was passed by Congress over the President's veto, the output of silver was reported by the Bureau of the Mint to have been $45,200,000. In 1892 the figures were $82,101,000. In the following year production declined to $77,576,000, and in 1897 the output was $69,637,172.

These official figures all refer to coining values and to calendar years. The commercial value of fine silver has fallen from $1.32 an ounce in 1869 to about 61¼ cents an ounce at the present day. The commercial value of the silver product of 1897 was $32,316,000.

The production of gold has not kept pace with that of silver in this country, notwithstanding the considerable increase in the past few years. The output of gold from 1873 to 1896 inclusive, as determined by the Bureau of the Mint, was 42,751,613 fine ounces; the output of silver in the same period was 998,411,000 fine ounces.

High water mark in the production of gold was reached as long ago as the year 1853, when the output was 3,144,374 fine ounces (value, $65,000,000). In 1869 the output was 2,394,563 fine ounces ($49,500,000) and, with one or two exceptions, each subsequent year showed decreasing production until 1883, when the minimum amount of 1,451,250 fine ounces ($30,000,000) was recorded. Each year since has shown an increase, and in 1897 the gold product of the United States was 2,774,985 fine ounces, of the value of $57,363,000.

The report of the Director of the Mint upon the production of the precious metals for the calendar year 1897, recently submitted to the Secretary of the Treasury, contains some impressive figures.

It is shown that the production of gold in the United States increased $4,275,000 in 1897 over that of 1896. South Africa made a gain of $13,854,192, Australasia a gain of $10,502,249, and Russia a gain of $1,709,970 in the same period of time.

In 1897 the value of the total gold product of the world is stated to have been $237,504,800 and that of the total silver $236,730,300 (coining value).

In 1887 the total production of gold is shown (in other official tables) to have been $105,774,900 or less than one-half that of 1897, and the total production of silver was $124,281,000, or a little over one-half that of 1897.

If we go back still farther to the decade of 1811 to 1820, inclusive, we find that the total production of gold in the world during this period was but $76,063,000, or less than one-third of the production in the single year 1897, and the production of silver in any single year of that decade was less than one-tenth of the production in 1897. The production of gold in 1897 was almost exactly equal in value to the entire production of the world during the quarter of a century from 1811 to 1836.

The production of gold in the United States in 1897 was not the largest in the history of this country, as already stated, but it was the largest since 1854. In that year gold was produced to the value of over $2,500,000 more than in 1897, while in the previous year, 1853, there was produced more than $8,500,000 in value of gold in excess of the output of 1897. The enormous production in 1853 and 1854 was due to the discoveries of placer gold in California. These were the banner years, and production of gold in the United States gradually declined from that time until it reached the lowest ebb, in 1883, when it amounted to but $30,000,000 in value.

About fifteen years ago, improved methods of getting gold from low grade ores and of refining base bullion and "doré" bullion (silver containing a small percentage of gold) began to be commercially developed, and in consequence thereof the production of gold has increased year by year. For these and other reasons, it seems probable that the yearly production of gold in the future will show a gradual increase and will be less subject to fluctuations than it has been in the past.

While it is true that nuggets, grains, and dust are still found by prospectors in newly-explored regions, most of the gold is now obtained from widely distributed low grade ores by the aid of scientific processes. Notwithstanding the excitement over the Klondike discoveries, the output from that region is insignificant so far when compared to the total product of the country. Statistics show that the State of Colorado alone added twice as much gold to the world's stock in 1897 as did the Klondike region, and several other States largely exceeded the Klondike output.

The statement of the Director of the Mint that the gold product of the South African Republic exceeded that of the United States in 1897 is apparently creating much astonishment and comment just now, but the monthly returns (unofficial) from that region show that the output for ten months of the present year exceeded that of the entire year 1897, and it is estimated that South Africa's contribution in 1898 to the world's stock of gold will be not far short of $70,000,000.

American mining engineers who have been engaged in developing the South African gold fields have computed from surveys of the ground and numerous assays of samples of ore taken from different localities and at different depths that the gold contained in the ore in sight in the district known as the "Rand," or Witwaatersrand, amounts to the enormous value approximately of $4,000,000,000, and at the present rate of production it will take half a century to exhaust these deposits, even though no further discoveries be made. Australasia and the United States together produced more than one-half of the entire output of gold in 1897, and it is in these two countries that modern methods have been most largely adopted. Gold getting has been changed by modern scientific methods from a lottery to a comparatively safe, even if more prosaic business, and for this reason, if for no other, the suitableness of this noble metal for use as a universal measure of value is rendered even more apparent than in former years when the production was subject to greater fluctuations. The increase in production is keeping pace with increase in population, and the leading nations have long realized that while in former ages, beads, shells, skins, cattle, tobacco, farm products, tin, lead, copper, and other metals have served useful ends as money, there is, in the present stage of development of civilization, but one material adapted to fulfill the function of a universal measure of value of all commodities, including labor, and this is the metal gold, which is, fortunately for mankind, so widely yet sparingly distributed that the increasing requirement for this purpose and increasing supply seem to regulate each other in a truly wonderful way.

Owing partly to the increasing magnitude of silver deposits at the Philadelphia Mint, commencing about 1871, and partly to a natural predilection for the analytical methods of the "humid assay" of silver, this work became the speaker's special occupation during the following ten years. Assays of silver increased from an average of about a dozen per day in 1870 to more than one hundred on many days in 1876 owing largely to the coining of "trade dollars," of which 35,965,924 in all were struck before this coinage was suspended.

After the passage of the Bland-Allison Act, in 1878, the silver deposits and assays increased to a still greater degree.

In 1881, the year in which the speaker resigned from the Mint to become the metallurgist of a private manufacturing establishment, the production of silver in the United States was nearly four times greater than in 1869, when he first entered the assay laboratory.

In 1873 Sir Norman Lockyer, the astronomer, and Prof. Roberts-Austen, chemist of the Royal Mint, London, announced to the Royal Society that they had discovered a quantitative method of assay of gold and silver by means of the spectroscope, which they expected would supersede the chemical methods then in use, and the speaker was thereupon authorized by the chief assayer of the Mint in Philadelphia to make a thorough study for the assay department of the proposed method.

The assayer caused to be made alloys of gold and copper, gold and silver, and gold, silver, and copper; these were carefully assayed, numbered, and delivered to the speaker, who took them to a private laboratory in the University of Pennsylvania, set apart for this experimental work, in which there was placed for his use, by the courtesy of the professor of physics, a large spectroscope, a powerful Ruhmkorff coil and galvanic battery. Here the study of the spectra of the gold and silver alloys was carried on daily for over six months, a special instrument having been devised for holding the specimens, and constructed in the Mint by the late S. James, master mechanic.

A report was made in 1874 to the assayer, which was communicated by him to the American Philosophical Society, and published, with photo-relief reproductions of the original drawings, in their Proceedings (Vol. XIV., No. 93, Trans. Am. Ph. Soc.)

The chief assayer of the Mint, the late W. E. Du Bois, in presenting this report to the American Philosophical Society, on May 16, 1874, gave the following introduction:

"It must have occurred to many, when the brilliant spectroscopic method of scientific research succeeded in detecting the presence of metals, in any given sub-

* Abstract of an address by Alexander E. Outerbridge, Jr., President of the Mining and Metallurgical Section, and published in the Journal of the Franklin Institute.

stance, even to an infinitesimal nicety, that the next step must be to determine the proportion of such presence; in other words, the qualitative must lead to the quantitative, as in other chemical processes.

"The annual report of the Royal Mint at London for 1872 (dated April 15, 1873) contains an official memorandum of Mr. W. Chandler Roberts (now Roberts-Austen), chemist of the mint, from which it appears that he was engaged in examining this subject at the suggestion of, and in connection with, the distinguished spectroscopist and astronomer, Mr. (now Sir) J. Norman Lockyer. No decided results had been reached; but Mr. Roberts concluded by expressing the belief that every effort should be made to render the instrument serviceable in the operations of minting. . . . It seemed desirable that our own mint should maintain its character for examining and adopting real improvements, and not wait indolently to hear what might be done abroad.

"One of the assistants in the Assay Department, Mr. Alex. E. Outerbridge, Jr., had for several years given special attention to spectroscopic studies, both in theory and in practice, and to him therefore the subject was committed; with what propriety and what success will sufficiently appear from what he has written. This will be found in the two following communications to the assayer.

"The details he has given are well worth careful study; but we cannot help noticing, in a few words, the astonishing paradox at which his experiments arrive; namely, that this method is, in one respect, by far too sensitive and minute; and in another respect far from being minute enough, to serve the uses of the assay. It was worth all his patient labor many times over to come to this conclusion, as we must come, in the present state of this branch of science. And it is likely that the natural and necessary imperfections of metallurgy, the want of complete atomic homogeneity in the mixing of metals, will forever prevent the spectroscope from taking the place of the present methods of assay.

"As Mr. Outerbridge has been careful to give facts rather than suppositions, he has omitted any explanation of the anomalous results in the final part of his report. And yet, it seems evident that where two metals are present, the spark will, to some extent, elect for its vehicle the one which is most readily vaporized. This is notably shown in alloys of gold with copper. It is also very striking in the alloy of nickel and copper of which our 5-cent piece is made. The nickel, which constitutes one-fourth, controls the color of the alloy entirely; and yet, being far more difficult of fusion than the copper, scarcely shows a trace in this spectrum analysis. . . .

"These experiments, it is believed, will be of use to show what may, and what may not, be expected from the spectroscope in the way of analysis where several metals are components.

"They may also be of use in other departments of investigation."

The report showed conclusively that the novel method, though interesting from a scientific point of view, was not practical, owing partly to the almost infinitesimal amount of metal volatilized by the spark, which metallic vapor was the subject of quantitative analysis by the spectroscope. The report was reprinted in The Journal of the Franklin Institute, the (London) Quarterly Journal of Science, and other foreign journals, and its conclusions were, it is believed, accepted as final, and the chemical methods of assay still prevail.

The speaker said that an unexpected appointment in 1876, as Resident Commissioner to the Centennial Exposition from one of the smaller colonies of Great Britain, resulted in forming pleasant acquaintances and valuable connections with several other foreign commissioners representing important gold-producing regions of the world.

The exhibit of gold ores, nuggets, and minerals from Australia was particularly fine. A notable feature was the display of fac-similes of the most famous gold nuggets that had been found in Australia. One of these, discovered in 1869, called the "Welcome Stranger," weighed 2,268½ ounces, and was sold for £10,000 sterling.

The fac-similes were made of plaster of Paris, heavily coated with gold leaf, and dusted with ferruginous clay in certain spots and cavities, and it was said that they resembled the originals so closely, that they could scarcely be distinguished from the genuine nuggets even by a critical eye.

On his way to Philadelphia, the Australian Commissioner stopped for several weeks in London, in order to exhibit the collection at the Crystal Palace, or some similar building. The night before the opening day he was at work until a late hour with his assistants, and the last case unpacked contained these fac-similes; they were placed in a glass showcase with the labels attached, stating the value of each original nugget, and each card had a small word (fac-simile) in one corner.

The next morning the commissioner was astonished to find a guard of metropolitan policemen drawn up in front of the showcase, and he then learned that the night watchman, discovering all this wealth of gold, as he supposed, exposed in a glass case, not even locked, called the superintendent of the building, who sent post-haste for an emergency guard.

One of these gilded fac-similies was secured by the speaker at the close of the Centennial Exhibition and deposited in the cabnet of curios at the Mint, where it has often been mistaken for a large lump of virgin gold.

In 1876, a pioneer of the South African gold fields visited the Centennial Exhibition and brought with him a number of valuable nuggets, which he subsequently deposited in the Mint. He was an intelligent Scotchman, and he said to the speaker, "After the rich alluvial gold shall have been all taken by prospectors like myself, others will come with machinery and secure far more gold from the refuse ore than the pioneers ever dreamed of." This prediction has come true. The Transvaal now leads the world in annual production of gold.

The cyanide process of recovering gold from low grade ores has been brought to great perfection in South Africa by American mining engineers, and the most recent publication by Ellsler states that nearly one-third of the gold of the Rand is now obtained by this process.

The speaker said that, in 1881, he read a paper before the Numismatic and Antiquarian Society descriptive of minting methods, and as these are practically the same to-day as at that time, this description will still suffice to show the delicate chemical and metallurgical processes and intricate mechanical operations that are necessary to convert the precious metals into the coin of the nation.

Minting Methods.—The precious metals are never found in the pure state, and they are deposited at the Mint alloyed with other metals, and in a great variety of forms, such as native grains, dust, amalgam, bars or pigs, old jewelry, etc. The mixed metals are known under the generic name of "bullion."

The bullion is first weighed in the "deposit weigh room," where several balances are kept for the purpose; the largest of these will weigh as much as ten thousand ounces in one draught, and the scale will readily turn, even when loaded to its full capacity, with a weight of one hundredth part of one ounce. The metal is then placed in a box provided with a cover and lock and taken to the "deposit melting room." Here it is put in a crucible which has been previously heated in the melting furnace and covered with a thin coating of borax, which forms a sort of fluid glass, acting as a cover to protect the metal, when it is molten, from the oxidizing influence of the air. A workman wearing a pair of large canvas mitts (somewhat resembling boxing gloves) grasps, with a pair of iron tongs, a rod or stick made of plumbago, he stirs the now fluid mass back and forth, up and down, round and round, for the purpose of rendering it thoroughly homogeneous; the metal is then cast into an iron mould called a "shoe." It is plunged into water to cool, as well as to dissolve off any particles of the borax glass which may have adhered to its surface. It is now returned to the weigh room and reweighed.

A slight loss in weight usually occurs owing to a partial refining out of the base metals, and the new weight is the amount with which the depositor is credited.

Let us suppose that a depositor brings a miscellaneous assortment of old gold; watch cases, jewelry, dentist's plates, etc., representing every grade of fineness or proportion of pure gold, desiring to obtain its equivalent in coin. We will follow in imagination the usual course pursued.

After the metal has been returned from the melting room (where it was cast into the shoe mould) and the bar reweighed, a small chip is cut off from one end of the bar and taken to the assay laboratory.

The Analysis.—The sample is laminated or rolled into a thin ribbon and stamped with the number of the deposit which it represents; it is then assayed to determine the proportion of gold, silver, and base metal, and so accurate are the processes of assay, that the exact value of a deposit, frequently aggregating many thousands of dollars in value, is determined to the fraction of a cent by calculations based on the assayer's report.

The largest weight which the assayer uses in making an analysis of gold bullion is the French half gramme (or about seven and three-quarters grains troy).

The balances used in this work are marvels of mechanical construction; they are so sensitive that a weight of one-twentieth of a milligramme (less than one-thousandth part of a single grain) will cause the indicator needle to deflect a very appreciable distance from the zero point on the graduated scale marking the equilibrium. These little balances are inclosed in glass cases, provided with sliding windows to exclude any draught of air. The beam is usually made of aluminum, one of the lightest metals, and the knife edges rest on jewels. The weights are made of gold, silver and aluminum, and are graduated from the half gramme, which is arbitrarily denominated "1,000," down to the ten thousandth degree.

The assayer first determines approximately the relative proportions of the metals existing in the alloy, and from this bases his more careful determinations; he weighs out on the balance exactly one-half gramme, or one thousand parts of the alloy; he wraps this in an envelope of pure lead and rolls it into the form of a "bullet." The bullet is then placed in a small "cupel" or cup, made of calcined bone dust, which has been brought to a white heat in the muffle or oven of the assay furnace.

The mass melts immediately, and the lead oxidizes rapidly by absorbing oxygen from the heated air which passes continually over its surface, and on account of the extreme fluidity of the oxide it sinks into the pores of the cupel, which absorbs it as readily as a sponge absorbs water; the lead also carries with it all the base metals which may be originally combined in the alloy, but the precious metals not being oxidizable, simply melt, and are not so fluid as to be capable of sinking into the cupel. A separation thus takes place, and at the moment when all the base metal is removed, a beautiful "flash" is observed to take place on the surface of the metal; the "button" of purified gold and silver resulting from this operation is then removed from the cupel, returned to the balance, and weighed; the loss indicates the proportion of base metal. Another weighing of the sample is then made, to which is added pure silver in the form of fine granules, in the proportion of about two parts of silver to one of gold, the alloy is inclosed in a sheet of lead and cupeled as before; the silver button remaining is laminated, coiled into a roll called a "cornet," and boiled in nitric acid. The acid dissolves the silver, leaving a little roll of nearly pure gold.* This gold cornet is then annealed in the furnace to give it toughness, and is finely weighed; this weight represents the proportion of pure gold. The proportion of silver is ascertained by subtracting the weight of the pure gold plus the weight of the base metal from the original weight of the assay sample.

Silver was formerly assayed in the same way, but it was long known that the result was not quite accurate, owing to a partial volatilization of the metal when exposed to the high temperature of the fire. Experiments were instituted by the French government to overcome this difficulty, which resulted in the beautiful "humid process" devised by Gay-Lussac. This is one of the most accurate methods known to chemical science, and so complete was Gay-Lussac's original description that little room has been left for any improvements, and many thousands of dollars' worth of silver bullion are rapidly and accurately determined every day in the Mint in this way. The rationale of Gay-Lussac's method is very simple, viz.: A given amount of chlorine will precipitate a definite proportion of pure silver from its solution in nitric acid.

The assayer prepares two solutions of common salt water (chloride of sodium); one is known as the "normal solution," and the other as the "decimal solution." One begins and the other finishes the assay.

The sample of silver to be assayed is weighed out, as in the case of gold, the assayer taking care to place a sufficient weight of the alloy in the scale pan to contain at least one gramme (a little over fifteen grains) of pure silver; the weighed sample is then placed in a glass bottle and a charge of nitric acid is added to it; the acid is caused to boil, and in a short time the silver alloy is completely dissolved.

A charge of the normal salt solution is then allowed to flow into the bottle from a glass "pipette," which is made of such capacity that it shall contain just enough salt water to precipitate one gramme of pure silver: the chlorine in the salt water combining instantly with the silver, precipitates it in the form of a white cloud; the bottle is agitated rapidly for a few moments, when the precipitate settles to the bottom, leaving a clear solution above; the assayer next allows a charge of the "decimal solution," which is one-tenth the strength of the normal solution, to flow into the bottle from a burette or glass tube with graduated divisions, each division marking one-hundredth the capacity of the large pipette. If any silver remains in the solution, a cloud will be observed on the surface. Now, as this decimal charge is one-tenth the strength and one-hundredth the volume of the large pipette, it will, of course, precipitate just one-thousandth as much silver, or one milligramme. The bottle is again agitated to settle the precipitate, and successive charges of the "decimal solution" are added until all the silver is precipitated, and then a simple rule-of-three sum gives the exact proportion of pure silver contained in the original weight of the alloy. The assayer guards against all probable sources of error by an elaborate system of checks, and each set of assays is accompanied in all its mutations by one or more "proofs" or synthetic assays, made either from pure metal or from alloys of known composition.

After the exact proportions of gold, silver, and base metal constituting the alloy have been reported by the assayer to the superintendent, the value of the deposit is calculated, and the depositor is paid the full equivalent, less the charges for refining, the amount of charges depending, of course, upon the nature of the bullion.

The Refining Process.—The metal now passes into the hands of the "melter and refiner."

We will suppose that the representative deposit that we have already alluded to contains a small percentage of base metals, such as tin and lead, which tend to make the alloy brittle or "short," rendering it unfit for coin.

The first operation to which it is subjected is intended to eliminate these impurities, and is called "toughening." The metal is melted in a crucible and an oxidizing flux (saltpeter) is added to it while fluid. The saltpeter or niter decomposes and liberates oxygen gas; the oxygen seizes the base metals, forming oxides; these rise to the surface and are dissolved in the flux; the flux, when sufficiently thick, is skimmed off, and the purified metal, consisting only of gold and silver, is poured into cold water to form granulations. The next operation is designed to remove the silver. This is effected by boiling in nitric acid, when the silver dissolves, leaving the gold in a finely divided state.

The "plant" used for this purpose consists of a number of large porcelain jars capable of holding about thirty-five gallons each.*

These are arranged in a double row and heated by steam pipes; they are inclosed in a chamber provided with sliding doors to prevent the escape of the noxious fumes, which are carried into a tall chimney, from which they issue in a yellowish cloud. The dissolved silver is drawn off by means of a large siphon made of native California gold (valued at $3,000) and transferred to a vat made of wood (capacity 2,000 gallons), resembling those used in breweries. The vat contains several hundred gallons of salt water, and the silver is precipitated by the chlorine, a workman facilitating the operation by agitating the liquid with a large paddle provided with a long handle.

The precipitated silver is drawn off into large filters placed on trucks and thoroughly washed by running water until the test of litmus paper shows that all trace of acid has been removed. The chloride of silver now resembles pure white cottage cheese. It is transferred to another vat lined with lead. Zinc (which has been previously granulated by pouring while melted into cold water) is added to the silver, together with a little sulphuric acid; the chlorine deserts the silver for the baser metal, forming a soluble salt of zinc. The solution is allowed to flow off, and the precipitated silver, after having been thoroughly washed, is pressed into round cakes called "cheeses," dried in an oven and melted in the furnace; it is finally cast into a bar, and is found to be uncontaminated with its former base associates, being usually 998 to 999 fine.

The gold which remained in the porcelain jars is in the form of fine powder, and resembles sifted gravel.

After thorough washing to remove the silver nitrate, the gold sediment is placed in cast-iron pots and boiled in strong sulphuric acid with a little niter added; it is then washed, dried, pressed into cakes, and melted. The bars are nearly pure gold, about 999 fine.

All that now remains for the melter and refiner to do is to weigh out the requisite amount of copper to form the coin standard, which is 9 parts of gold or silver (as the case may be) and 1 part base metal. In other words, our coin standard is nine-tenths fine.

The alloy is melted in large crucibles made of plumbago, holding over 6,000 ounces, and constantly stirred to render the mass homogeneous. The standard metal is cast into flat bars called ingots, 12 inches long, ¾ inch thick, and from 3¼ to 1½ inches wide; the ingots are filed to remove the ragged edges, and the rough tops cut off with large steam shears. Two samples from each melt are assayed, and if the ingots are found

* A faint trace of silver remains undissolved by the acid, called the "surcharge." The amount is ascertained by proof assays, using gold 1,000 fine, and proper allowance is made for the sur-charge of silver.

* The charge for each jar is usually 190 pounds of granulations and 175 pounds strong nitric acid.

to be of the proper fineness and of uniform composition, they are delivered to the coiner.

The Mechanical Processes.—The coiner transfers the ingots to the rolling mill, and when they have been sufficiently laminated by successive rolling and annealing, the strips are passed through a machine called the "draw bench," for the purpse of reducing them to the exact thickness required for the coin. This operation is similar in principle to wire drawing, and consists simply in squeezing the flat strips of metal between two stationary steel cylinders set to the desired gage. The strips are now passed to the cutting press, which consists essentially of a round punch, the size of the "planchet," or blank required for the coin, working up and down very rapidly into a hole on the steel bed plate.

The strips are passed by hand through the press, and the blanks fall into a box below. The unused portion of the strips, or "clippings," is returned to the melter and refiner and remelted. The planchets are next taken to the "adjusting room," where may be seen a number of ladies seated at a long table, each one provided with a little balance and a file. Each lady is supplied with a pile of planchets, and she proceeds very deftly to weigh each one against a properly adjusted counterweight. The planchets that are too light are thrown into a separate pile and returned to the melter and refiner, to be remelted with the clippings, while those that are too heavy are adjusted by filing on the edge. Some years ago a novel automatic adjusting machine, designed by Mr. Ludwig Seyss, of Vienna, was introduced for the purpose of facilitating the work and diminishing the necessity of hand labor. It is an exceedingly beautiful and ingenious piece of mechanism, but is too complicated to admit of an intelligible description without the aid of sectional drawings. A description of this instrument will be found in The Journal of the Franklin Institute of February, 1878. It not only weighs the blanks automatically, but also separates them into three kinds; those that are too heavy falling into one box, the light ones into another, and those of the right weight into a third. The machine will weigh and assort as many pieces in an hour as five expert ladies can by hand, but when we consider that there are ten balances in the machine, engaged in weighing at the same time, and only five used by the ladies, they must be awarded the palm for expedition.

The machine also requires the constant attention of one person to supply the blanks or planchets, and frequent attention of the expert adjuster of balances. When the additional cost of steam power and wear and tear of the parts is added to the original cost of the apparatus, its merit from an economical point of view is not so great as would at first sight appear.

The next operation to which the blank pieces are subjected is to impart the raised edge, technically called "milling."

The machine used for this purpose is an American invention, and is admirable for its simplicity as well as for the rapidity with which it accomplishes the work.

The blanks are fed by an attendant into a tube, and they are drawn horizontally, in single file, through a gradually narrowing channel formed by a groove in the periphery of a rapidly revolving disk on one side, and a stationary segment of corresponding curve on the other, keyed a little closer to the wheel at one end. The blanks are in this way compressed on the rim, acquiring the "milled edge." This machine is capable of milling as many as 1,200 pieces per minute.

The blanks are now taken to the pickling vats, where they are immersed for a couple of minutes in weak sulphuric acid for the purpose of removing the black oxide of copper; they are then washed in pure water and placed in a rotating cage filled with sawdust. This rapidly dries the blanks, and when removed to the coining room they have acquired a fine surface.

The Coining.—The early methods of coining were exceedingly crude and imperfect. The metal was hammered into a thin plate; pieces of irregular size were cut out and beaten into a bullet shape; this bullet was placed on a sort of anvil having the reverse die cut upon its face.

The obverse die was held in the hand like a punch, and by the aid of a heavy hammer the bullet was flattened out and coined at the same time.

There are many interesting specimens of this antique coinage to be seen in the Mint cabinet. The oldest are to be found in the case devoted to coins of the Greek republic, dating back to seven centuries before the Christian era. It was not until the middle of the sixteenth century that the forge and hammer were succeeded by more scientific methods.

Formerly coins were struck in presses worked by a screw; but we adopted many years ago the admirable invention of a Frenchman, named Thenollièr, which has been further improved upon by the skill of a former coiner, the late Mr. Franklin Peale. This machine operates on the mechanical principle of the "toggle joint" (of which the elbow joint is a familiar example). It is controlled by a lady who feeds it with the blanks, which she places in a vertical tube. A pair of "feeders" catch the bottom piece and carry it forward, where it rests in the "collar" between the upper and lower dies. The lever is now descending with the upper die while the lower die remains fixed. The pressure increases with perfect uniformity up to the maximum, which is equivalent to about 10 tons for the dime, 80 tons for the double eagle, and 120 tons for the silver dollar. The pressure gradually decreases again by reason of the relaxation of the upper joint, the lower die pushes the pieces out of the collar into which it has expanded, and from which it acquires the "reeded edge." Meanwhile, the feeders have provided another blank, and as they bring it forward they push the coined piece into a channel, through which it slides into a box beneath the machine. The coins are then inspected by the foreman, and any cracked or defective pieces set aside.

The larger denominations of coin are counted by hand, and the smaller pieces, as well as the "bronze" and "nickels," are numbered by means of a simple and ingenious arrangement called the counting board.

After the coins have thus been counted and weighed, they are tied up in linen bags and delivered to the treasurer in drafts of $5,000 each. The accuracy of the adjustment of the weight is so nice that there is rarely a deviation from the true standard weight of as much as $\frac{1}{100}$ of an ounce in any delivery of either gold or silver coin.

As a final precaution, the assayer is required by law to select at random one coin from every lot of $20,000. These are sealed in envelopes, numbered, and placed in a strong box provided with two locks; the key of one is kept by the treasurer and the other by the assayer. These sample pieces are called the "pyx." They remain sealed until the commissioners appointed by the President assemble at the "annual assay" in February of each year to test their purity and weight; and it has rarely happened that any piece has been found to exceed the small limit of "tolerance" allowed by law.

The manufacture of the dies for coin requires a high order of artistic and mechanical labor, involving the talent of the designer and the skill of the engraver and sculptor. A detailed description of the processes involved would necessarily extend this paper beyond the limits assigned to it. A brief outline must, therefore, suffice. The artist first makes a free sketch on paper, he then models his design in wax upon a glass plate, and it is probably five times the size intended for the coin; from this he takes a cast in plaster, which serves, when coated with plumbago, as a matrix, from which an electrotype in copper is obtained. The electrotype, after being finished by hand, is used as the model from which the steel die is cut by means of a reducing pantographic cutting machine, somewhat similar to those used for reproducing designs for steel rolls used in making printed fabrics. A traveling pointer attached to the long arm of a lever is caused to move back and forth over all portions of the raised model, and a steel drill attached to the short arm is thus caused to cut the design in a block of steel corresponding in all its details to the model, but reduced to the proper diameter for the coin. The stars and lettering are now added, and the whole is finally touched up by the hand.

This design is called the "Hub" or "Master die." From it the coining dies are made and reproduced in any number required. A block of steel, having been softened by annealing, is placed in a screw press carrying the "hub," and by a succession of blows, followed by frequent annealings, the die from which the coin is to be made is produced.

It is possible (owing to the great value of the raw material) to bring the processes involved in our gold and silver coinage to a perfection which would not, perhaps, be found profitable in any ordinary industry; and this fact, together with the national pride which is felt in the matter, should offer encouragement to the invention of all practicable methods of producing perfect work and preventing losses.

A SCHOOL FOR THE MOTORMEN OF ELECTRIC CARRIAGES IN PARIS.

THE Compagnie Générale des Voitures, of Paris, are actively pushing forward the construction of their new electric vehicles, which are no longer a novelty upon the streets of Paris, where they have been plying for hire for some time. At Aubervilliers, near Paris, they own a tract of land which is given up to the education of motormen of the new vehicles. A road or track about

TRACK FOR INSTRUCTING DRIVERS OF AUTOMOBILE CARRIAGES IN PARIS.

2,500 feet long is used for this purpose. Part of the roadway is made of macadam and part of it is paved with stone, and a portion with wood. Inequalities of all kinds are introduced into the road. The new motormen are drivers who are usually ex-coachmen, who are given electric carriages and are forced to run them over the course, which is well sprinkled with obstructions in the way of bricks and painted boards which are secured in an upright position by a brace. These boards represent ladies and gentlemen, boys on bicycles, children playing, nurse girls wheeling baby carriages, etc.; in fact, all the usual things which a driver is to look out for on the Paris streets and boulevards are present. The vehicles are required to pass around these various obstructions without injuring them. Our engraving shows an embryo motorman avoiding a bicycle on his left and a baby carriage, a child and a dog on his right. The system of instruction is novel and efficacious, and it is surprising to know how few accidents really occur, even where only painted silhouettes can be injured. For our engraving and particulars we are indebted to L'Illustration.

EXPLOSION AT THE CHAMPEAUX RESTAURANT AT PARIS.

ON Sunday, November 20, 1898, at about five o'clock in the afternoon, there occurred a terrific explosion in the Champeaux restaurant at Paris, which killed several persons and caused considerable damage. This restaurant, which is situated on Place de la Bourse, occupies the entire ground floor of a house of which the upper part contains the offices of the Havas Agency.

This ground floor is elevated about three feet above the sidewalk, and access from the exterior is obtained through a flight of steps. The basement comprises, in addition to the kitchens, vast cellars that were formerly the vaults of a convent. It was here that occurred the explosion, which, according to the inquest, was due to the sudden ignition, through a candle, of a large quantity of illuminating gas that had accumulated in the vaults.

On the outside, a huge iron cellar door, weighing more than three hundred pounds, was torn loose and thrown to a distance of two yards, and crushed a lady who was passing by. In the interior, the Cyrus Saloon and the Vert Saloon, fronting on Place de la Bourse, fell in, while the floors of the two saloons at the back were lifted, and the window glazing of the winter garden flew into atoms.

This attractive restaurant, wherein two hours later there would have probably been numerous Sunday diners collected, offers at present a sorry spectacle,

FRONT ENTRANCE.

THE CYRUS SALOON AFTER THE EXPLOSION.

EXPLOSION IN THE CHAMPEAUX RESTAURANT, PARIS.

that of an indescribable pellmell of chairs and table overturned among the debris of table ware and glass.

For the above particulars and the illustrations we are indebted to L'Illustration.

THALASSIC SUBMERSION A MEANS FOR DISPOSAL OF OUR DEAD.*

By D. LICHTY, M.D., Rockford, Ill.

THE question most intimately following a useful existence here is a harmless absence after we are through. It is evident that some suggestion for the disposal of our dead, other than earth burial or cremation, is needed, from the unsanitary character of the former and the natural repulsiveness of the latter.

To show that ocean burial is practical, sanitary, and will meet most of the requirements of sentiment and religion, and all those of sanitation, will be the endeavor of this argument. That the beautiful fealty of genealogy and consanguinity and the sacred associations of religion are factors to be considered in this as well as any other method for the disposal of the dead is recognized; but above and beyond these is the unpurchasable boon of health and its attendant uses and beauty.

Every expedient that human thought could devise has been resorted to in all times past to conceal the human dead and escape their disagreeable, decaying presence and evade their naturally dreaded and noxious effluvia. The nomad's village was removed to fresher and more remote territory; the ancestral cave was promptly deserted and relinquished to the grim destroyer; the rare and desiccating air of the plains did well preserve the body until disintegrated and distributed to the sands and dust; birds and beasts of prey were invited to devour the softer tissues while the bones bleached in the sun and the mists. Chemistry has been invoked to offer an element that would preserve our form or else dissolve it quickly away; and modern electricity has been asked to envelop the loved ones in impermeable garbs of metal to preserve their cherished form and substance. Aquation or sea burial, except in accidental death at sea, was only practical when navigation was so primitive that the hardiest mariner dared not go beyond the shallows or out of sight of his native land, and when bathymetry and geodesy of the ocean were unknown. The embalmers, from the Egyptians to the present, exhausted every resource of their art, then and now, to prevent the decay of the body; but Rameses' and Cleopatra's crumbling and repulsive features, held together with spiced pitch and rags, as seen in modern metropolitan museums, attest its grewsome failure.

All these have failed to satisfy the longings of devotion to our dead, or meet the present rigid sanitary requirements of our rapidly multiplying and dying population, and we seem to have still nothing left but to "inhume the natives in their native plains."

Earth burial remains an unsatisfactory and unsanitary presence as well as relic. Incineration continues repulsive to all the finer feelings of nature, and we seek relief from all these in the truly sanitary, beautifully sentimental, and forever efficient disposal of our dead in the depth and vastness of the abyssal area of old ocean—illimitable and itself symbolic of the infinite in time and space—bride of the sun and vassal of the moon! "Nothing in nature renders back to man the full and instant sympathy which is accorded by the mighty seas," who thus repose mildly in the generous grandeur of their glorious power.

Sentiment must have a place in this presentation, and in this every department of this subject can have a diversion and division as remote as mythology, as exact as history and science, and as generous as poetry aided by the imagination can plan, from Charon with the obolus, to pay passage, to Tennyson's "Crossing the Bar;" from "Jordan's Stormy Banks" to "Canaan's Happy Shores."

As we emerge from the eras of superstition and shallow thought, and realize that the organic individual is but a transient here, and that disintegration and resolution of the body into its primitive elements is but an arc in the circle of perpetuation; that care for the living, hope for the future, and memory for the dead is our aim and object, so does it become forcibly apparent through every channel of study that the now well acknowledged bane of earth burial must somewhere, somehow, cease. The catacombs everywhere, instead of being monuments of skilled subearth engineering, are rather persistent evidences of a civilization so remote and crude that, without implements of excavation, they could only follow the sand strata and rock seams in their meanderings toward "points of least resistance" for repositories for their dead. An afterthought, with the then generally entertained idea of immortality of the material body, led to the attempts at decoration and barbarous body ornamentation which the dry sand chambers and corridors favored by desiccating the bodies, absorbing the gases and preserving the then sacred and æsthetic attempts at color ornamentation for the amusement of modern sightseers.

The deception that proximity to graveyards is harmless cannot longer be maintained by corporations who own them or municipalities that are supposed to control them. The study of bacteriology and the toxins, their secretions and their persistent life in all conditions; the penetrability of their gases to remote distances through pervious qualities and strata of soil; their escape and ascent into the atmosphere, all impress the danger of such acres (though sacredly and sentimentally named) on chosen picturesque hillsides, near ravines draining the watercourses, or inclining to wells from which the inhabitants of villages and cities derive their water supplies and inhale the poison charged air.

Every aggregation of population is confronted with this menace. London has its finest cemetery—Kensal Green—of 18 acres, containing 70,000 recent bodies, an equivalent of 3¼ bodies to the space allotted an ordinary grave. Paris has its Pere la Chaise, equally crowded; in 1871 the communists made their last stand amid its tombs and 900 fell in its defense and were buried where they fell, in two long trenches, their bodies mingled with quicklime to hasten their dissolution. Other cities are struggling with this problem, owing to limit and contiguity of territory; building tombs above the earth; leasing the ground for brief periods only, and employing the chemistry of absorbents and deodorants and destructive acids to hasten disintegration, tossing the resultant dust to the garbage pile and fertilizing field.

A perusal of the daily lay papers furnishes a surfeit of ghastly recitals of graveyard desecration, of resurrection and demolition, of skeletons ruthlessly thrown about by workmen's pick and shovel within, or adjoining, hamlet or city, to make way for cable or conduit of commerce, or deep foundation for towering tenement. The category of horrors associated with our crude plan of earth inhumation and attempted body concealment, despite all precautions, is neither in harmony with wholesome sentiment, economy, nor in any sense approximate modern sanitary requirements. Every other phase of economics has advanced along progressive lines; ancient and modern plagues have been stopped; pain has been robbed of its terrors; time and distance have been annihilated; but a suitable and sanitary repository for our dead has not yet been secured. The "abyssal province" of the ocean, embracing 140,000,000 square miles, more than three times that of the earth's surface, and one hundred times that of the available area of earth, unfolds her limitless and aseptic bosom to envelop us; no actual bounds of length, breadth, height, or depth circumscribe her receptive capacity; the diversion of her

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shore lines is insignificant when compared with her area, and her perturbations are only on the surface; her deeper strata are scarcely moved in ages.

The wave
Unbroken in its tranquil aspect sleeps
Serene as Beauty in her sunless grave;
Nor moves a tide, unless its silent flow
Be through the graves and coral halls below.

Ocean cables lie secure in their beds and swerve not though pulsating with War's weighty messages or Love's tender tidings.

The antiseptic chlorin solution of the seas is as stable as air; dissipation and augmentation by affluents are compensatory and preserve a constancy of specific gravity. Its temperature at 400 to 1000 fathoms, in all latitudes, in all seasons, day and night, is unvarying and on the verge of freezing. Decomposition, putrescence—the dread of the surviving and the bane of the air and the earth—do not take place in ocean burial.

Imagination naturally revolts at the inexorable chemistry of decay that must take place in vault and subsoil burial; putrescence at the bottom of the sea is unknown; ferruginous matter does not find its way beyond the extreme three-hundred mile shore line, but here and beyond all is carpeted with pelagic deposits, crumbling remains of the inhabitants of the upper strata, feeding bathybius and the diatom, medusæ, and the crinoideæ. Here disintegration will some time, sooner or later, proceed by an alchemy unknown to the present denizens of the earth. Ships go down along the paths of commerce, but deep sea dredgings find no relic of the myriads that have sunk in her tracks; iron ships soon corrode and wooden ships are easily comminuted; ocean cables enveloped in heavy vulcanite remain long untarnished; gold, glass, and heavy porcelain survive; all else soon disintegrates and sleeps forever—a slow accretion to the solid diameter of the globe. Over all is constantly descending through the waters, like a snow cloud, showers of microscopic shells, product of the higher strata. At these depths there are no real or chimerical "sea monsters;" animal life diminishes in the sea as the depths become extreme. The investigations of Prof. Agassiz in the Pacific Ocean show conclusively that there are but few living forms below a depth of 1,800 or 2,000 feet; only minute and peculiarly formed and incrusted animal life can survive at this pressure.

Thus a body deposited on its "watery plains" or in its ferny cliffs, and marked on chart by degrees and minutes of latitude and longitude, would be as definitely located as if sepulchered in a mausoleum of granite on mountain side or village vale amid earth's shifting scenes.

Compare the area of the stable and abyssal seas with that of the earth, and its limitless boundaries invite undisturbed repose; subtract from the earth's surface lakes, mountains, marshes, rivers, and inaccessible territory, tillable lands for the sustenance of the living, and it leaves but a handful of earth for the myriads that already slumber in its bosom, or the unknown millions that shall live and die hereafter.

That change must come in the matter of the disposal of the dead is certain; that cremation during a third of a century of education and argument is far from acceptance and adoption is patent. Fire is the natural foe and dread of man, incineration cannot by any force or play of the imagination surround itself with as pleasing sentiment as ocean burial can. Resolution by fire is repulsive to all our nature; no one can come near a natural gas or fuel oil furnace, much less look into its glowing, roaring caverns, without being terrorized in its presence, and no persuasion could urge one to remain while the body of their friend dissolved and disappeared in its fury, or even while preparation was going on therefor. Besides this, it is too expensive for general adoption, and its hygiene and utility are still doubtful. The expense of a single Siemens retort in working order, without necessary buildings, is approximately $2,000. Sir Henry Thompson's process is more expensive, and Polle's but little less, in the experiments thus far made use of. By Polle's method two hours were required to reduce a body. Siemens' process required fifty-five minutes after the retorts had been brought to their required degree of heat. At the cremation of the body of the late Frances Willard the body was left in the retort all night, that the "ashes" might cool. This, in part, realizes the expense and impracticability of cremation when it should be applied beyond the experimental stage, and for those few only who, through persistent indoctrination, signified their willingness before death to submit to this form of dissolution. Witnesses to a cremation do not usually become advocates of the process. I asked a mother, three months after she had complied with her son's request to be cremated, and she had carried his body across three States to fulfill the promise, what she thought of it? She quickly dropped her head and an expression of horror was on her face when she looked up to ask me not to refer to it. The complaint of crematory managers is that parties do not even return for the "ashes," and their vaults are overcrowded.

Admitting that the expense of transportation to a suitable wharf and a distant crematory are equal, the further consummation by ocean burial would be far less expensive and less repulsive than cremation. The bidding adieu at the "Gates ajar" on a cleanly wharf, as a clean boat sailed away over the waters, would be far less trying and have a pleasanter memory than such a leave taking at the sooty door of a crematory, or to hear the final rumble of the clods on the coffin-lid six feet in the cold ground below. Further, the presence of a large crematory plant of say ten or twenty retorts would soon prove a nuisance in a neighborhood, and its location be as difficult to secure as that of a powder factory.

Consider an aggregation of population like New York and vicinity, numbering nearly five millions, and its death rate of 15 per 1,000, or 75,000 deaths per annum—over two thousand per day to be consumed; who could say that retorts, flues, and stacks would not soon be clogged? Imperfect combustion would result and noxious vapors therefrom fill the surrounding atmosphere. What a battery of furnaces and retorts this would require! No pleasing memories could cluster around such a place. No wonder that even material Germany shrinks from adopting the experiment, and of its dense population gave only a little over two hundred bodies to the experiment last year.

This subject has been presented to marines, travelers, landsmen; to Christian and infidel; and while with all, naturally, death is dreaded and the first suggestion of disappearance by submersion or by any means from the ken of men, is startling and dreaded; at a renewal of the subject after a time for thoughtful reflection they would invariably, as between earth burial, cremation or ocean submersion, favor a thalassic grave. As to incineration and urn and mantel preservation, fifty years after its revival from barbarous methods, aided by all the modern methods of propagating and advancing an innovation, its non-acceptance attests its failure. The proverbial dread of fire does not apply to water; submersion and disappearance beneath the wave cannot have associated with it the horror of disappearance by fire. Watery submersion as immersion is both a pleasant and a sacred symbol of burial and a new birth or resurrection to a large body of Christian believers to whom ocean burial should be a sure surcease from dreaded earth burial or incineration. A large percentage of suicides choose drowning rather than any other form of extinguishment, and prove their preference for a watery grave to plunging into a fiery retort at rolling mills or Bessemer converters.

There can be no very loving sentiment that may cluster around a bowlful of incinerated, gluey bones called "ashes" and summoning to memory a beloved face and form of which they were wont to form a part. Thoughts of the positive putrefaction of the loved ones, or how "the small, cold worm fretteth the enshrouded form," cannot be realized; or how beneath the coffin lid and its "six feet two" of weight of cold clods, rest cannot be more sweet and the form more secure than to be buried in the deep,

Where the sea flower spreads its leaves of blue
That never are wet with falling dew.

Religion and sentiment combine to explain why there is no more ready and favorable movement in favor of burning the dead.

Immortality that is to be had only by preserving a handful of bones or mourning over a mound of clay in God's Acre is indeed nothing much to be coveted. "We must be found in the register of God, not in the record of man." The memory of the child or parent cannot be less profound for the ancestral body that sleeps somewhere in fatherland, across the broader waters, the site of which they can never hope again to visit. Are the 150,000 brave sons, brothers, and husbands of our late civil war who sleep in unknown graves less cherished than those who sleep in "God's Acre" beneath the graven cenotaph? The white-capped emerald ripples in our national cemeteries marking the "unknown" indicate just as specifically where sleeps a hero and loved one as if they were buried beneath the green of Sargasso or the billows of the Atlantic.

We would not be retrograding either in sentiment or sanitation, if our seaboard population were not so dense, if we could revive the solitary, stately customs of the Viking chief, whose glory in defeat by death and in departure was to float outward to sea with the tide, reclining, surrounded by his trophies, in his crude but gorgeous craft until he was lost in the majesty of the sea, and sank to rest. The Columbia River Indians buried their dead by setting them adrift in their canoes with a lighted taper in the bow and watched the light and form go out on the broad sea and down together. Thus we are not advocating a custom that is without the sanction of precedent, or one that would conflict with the finer sensibilities of the surviving friends of those who at first voluntarily selected this method of burial, as has been done in cremation in the past.

It would seem that when ocean burial is rightly studied, when the abyssal area is considered, the aseptic fluid that will envelop the form, the quiet that rests in ocean's depths,

When winds were raging over the upper ocean,
And billows wild contend with angry roar,
'Tis said far down beneath the wild commotion
That peaceful stillness reigneth evermore.

Far, far beneath, the tempest dieth,
And silver waves glide ever peacefully,
And no rude storm, how fierce soe'er it flieth,
Disturbs the Sabbath of that deeper sea.

Comparing the accessibility for all the seaboard area and the economy with other methods of final disposal of the dead, municipalities or may be corporations would agree to add to the "white winged fleets of commerce," and the "white squadron of war," the pearly palaces of peace, that would at stated intervals, near enough together to meet the requirements of the district's mortality, sail away with their sacred cargo to deposit it on the watery plains of the abyssal seas, when with Byron we would say:

Ours are the tears though few sincerely shed
When Ocean shrouds and sepulchers our dead.

Such steamers should be especially fitted for their work; they should have complete refrigerating apparatus and chambers fitted to receive all the bodies to be carried; these chambers could also be hermetically sealed as "bulkheads," or salt water compartments, for the conveyance of contagious disease cases; they should be under the supervision and espionage of the municipal or State board of health. The wharves should be selected for their accessibility; should be capacious and scrupulously clean; fitting inclosure should secure the sacredness of the area, and within or adjoining might be a small, neat chapel. To those who still cherished the exclusiveness of the caste of wealth, rank or family—if death recognized such division—an area might be set aside in the abyssal field by the Geodetic Bureau, and they could be transported in their own or friend's private yachts, with such selected company as they chose, to share the sacred rite and private grief at the watery grave, where

The free waves kissed her with their cold blue lips,
And then put her to sleep;
She has a sand pillow and a water sheet,
And never turns her head or knows 'tis morning.

The caskets or containers might be wicker wrought, as has been suggested for earth burial, though fastened on a heavy iron or stone base; they might have fenestrated or latticed sides; or ornamental open work to admit water and favor deep submersion; a suitable weight could be inclosed in or near the foot of the coffin; if desired, this might be of any heavy non-corrosive material, with which might be a graven or moulded number or merited motto, corresponding to a record kept in the family or State archives for the information of future antiquarians, should islands some time rise "unushered from the seas;" where no provision had been made, a heavy concrete of water lime might fill the lower interspaces and insure descent and submersion. If volunteers were not offered, the "Potter's Field" might surely spare its inmates for the early experimental stage and no breach of sentiment could arise to offend the fastidious.

That bodies would rise again from the formation of gases, as they do in fresh water, is not to be anticipated, from the fact that the lowered temperature and aseptic medium of submersion would both prevent and lessen further formation of gases. It is of record that during the earthquake at Lisbon, in 1775, 60,000 people sank into the sea at once, and not one of the dead bodies ever floated to the surface. The water there now is only 600 feet deep, whatever it was at the time of the cataclysm.

That funeral obsequies and ostentation are becoming more and more a burden is an economic fact from which many would escape did not the thraldom of conventionalism prevent. Church funerals are becoming less frequent; the gorgeous hearse, the solemn, nodding plumes and the slow, and stately tread of somber caparisoned horses is giving way to the hurry trolley that ends at the gates to God's Acre. The money that is expended for the obelisk and the slab had better provide an endowment and a bed in a hospital for the unfortunate sick, crippled, or defective living. The fund that builds a mausoleum for the dead had better build a school or hospital; and the green cemetery field that is polluted with decay could in truth be made "God's Acre" when it was given up for park purposes, in which could be beautiful memorial plats and avenues, fountains, restful grottoes, inscribed settees, chapels with capacious corridors, with limited spaces assigned or purchased, on which might be inscribed in brief the record and memorium of the dead; libraries and art galleries might award or sell similar spaces.

Thus there would be no territorial encroachment in hamlet or city, and the forsaken and haunted cemetery would become a place of recreation, retrospection, and education for the living. Old Ocean would never become crowded, earth would be freer, water would be better, air purer. Life and health—the greatest boons of the Giver—would be strengthened and lengthened, and no harm have been done the dead.

R. Child Bayley recently read before the Royal Photographic Society a communication on the Melting and Setting Points of Gelatin Solutions and Their Modification, in which he detailed the results of some investigations carried out with the aid of an apparatus he described to the Society some two years ago, and dealt with the various influences which can be brought to bear upon gelatin, with a view to altering the temperature at which its solutions solidify and melt. It was pointed out that the setting and melting points are not identical, the setting point being generally about 8 degrees Centigrade below that of melting. The stronger the solution in gelatin the higher is the temperature at which it will set and melt, the rise being most marked in the case of the most dilute solutions capable of solidifying at all, and the effect gradually tailing off in the case of very strong solutions. The setting and melting points are lowered by prolonged boiling, and that eventually altogether destroys the power of setting. The author has invariably noticed that in the better grades of gelatin the effect of boiling is first to raise the melting point slightly. Prolonged boiling has a marked effect upon the color of the jelly; however white it may be at the commencement, it soon takes on a distinctly yellowish tinge, and to such an extent that the time of boiling may be readily estimated by the color alone. The effect of the addition of a large amount of potash alum is rather an alteration of the character of the melting and setting processes than a simple raising of the temperature at which they take place; the gelatin solution then ceases to have a definite melting point, and although for complete liquefaction a higher temperature is necessary, a partial action sets in at a temperature which is actually lowered by increasing the amount of alum present, while a still further increase gives total insolubility. With chrome alum, the effect produced by adding 1·2 grammes per liter of five per cent. gelatin solution is about the same as that caused by 5 grammes of potash alum, and anything over 140 cubic centimeters of commercial formalin per liter entirely destroys all power of remelting.—Brit. Jour. Photo.

With the new year it is likely many important changes will be made in the different departments of administration of the municipality of Paris, so that the streets and public buildings may be placed in the best possible condition for the Exposition of 1900. Just now the papers are discussing the pavement problem. According to the latest report, it costs annually from 23,000,000 to 24,000,000 francs to keep the streets properly paved. Although the wooden pavement is being rapidly developed, the stone pavement is most used, and now covers an area of 6,040,000 square meters. Simply for the recutting of old pavements 100,000 francs is expended every year. The recutting is done by the Paving Cutters' Association, which performs the work at the rate of about 70 francs per 1,000. There are about 1,600,000 paving blocks recut every year. The stone and asphalt pavements and their laying cost in the neighborhood of 9,000,000 francs; the maintenance of the wooden pavement, 3,000,000 francs. To these are added the sidewalks and courts paved with composition, to preserve which brings the annual cost of paving the streets of Paris up to nearly 25,000,000 francs. On these streets pass 50,000 vehicles every day, including 1,600 omnibuses and tramways, 15,000 wagons, 14,000 carriages, 13,000 carts, etc. According to municipal statistics there have passed on the average every twenty-four hours through the Avenue de l'Opera, 36,200 horses, drawing 29,500 vehicles, which is to the breadth of the avenue, 2,262 horses to the meter.

MISCELLANEOUS NOTES.

The total production of flax in Ireland during 1897 was 6,818 tons. It required 45,576 acres of land to produce this crop, and the yield per acre was 23·93 stones. In 1896 the total produce was 10,844 tons.

St. Helena has been the scene of a curious "Pooh Bah" performance. It possesses a bishop and also a governor, who is likewise chief justice. The bishop disregarded an injunction of the court and was fined £50 for contempt of court. He appealed to the colonial secretary, who ordered the governor to remit the fine. The bishop is still in contempt, and the governor has been compelled, as governor, to override his own action as chief justice.

The total number of vessels passing through the Suez Canal in the month of July last was 337, of a gross tonnage of 1,244,040 tons. Of these 337 vessels, 205 were British, with a gross tonnage of 761,359 tons; 35 German, 129,302 tons; 25 Spanish, 124,175 tons; 20 French, 78,381 tons; 15 Dutch, 41,338 tons; 4 Japanese, 23,472 tons; 4 Russian, 19,624 tons; 9 Ottoman, 15,838 tons; 5 Austro-Hungarian, 15,739 tons; 4 Italian, 14,034 tons; 4 Norwegian, 7,347 tons; 4 Egyptian, 6,543 tons; 1 Danish, 4,420 tons; 1 Chinese, 1,605 tons; 1 Greek, 971 tons.

Mr. G W. G. Ferris, the designer of the famous Ferris Wheel, which formed one of the most popular outside attractions at the Chicago Exposition, died a few months ago in a hospital in New York, of typhoid fever, brought on in part, it is said, by anxiety over business matters, says The American Architect. Mr. Ferris was born in Galesburg, Ill., and graduated from the Rensselaer Polytechnic Institute, at Troy, as an engineer. After several years' practice as an assistant, he began business on his own account as what might be called an inventing engineer. The Chicago Exhibition suggested to him the extraordinary plan which he worked out with such signal success, and which is said to have brought him a fortune.

The Eiffel Tower is to be "treated" with the view of rendering it more presentable and acceptable at the 1900 Exhibition, says The Builder. The lifts now in use are to be replaced by lifts "à grande vitesse" and with increased accommodation. The restaurant and concert room erections on the first platform are to be removed and the platform left clear. The "circular gallery" is to be widened by two meters all around, and the public are to be admitted to the top gallery also. The whole of the ironwork is to be painted a blue-gray tint, resembling the treatment of the ironwork in the "Beaux Arts" and "Arts Libéraux" palaces of the last Exhibition. The tower, which has hitherto only been lighted with gas, is to have an illumination of 10,000 electric lamps. Unfortunately, these changes will do little or nothing to ameliorate the general ugliness and the outrageous scale of this too-celebrated structure. It is to be hoped that after the 1900 Exhibition, at all events, it will be removed altogether.

A German contemporary, the Chemische Revue, recently contained an article by Dr. M. Albrecht, on the relative qualities of American and Russian petroleum. From the examinations made, Dr. Albrecht draws the following conclusions: 1. The flash point of the Russian oil is from 5° to 7° C. higher than that of American oil. The former, therefore, is safer, as far as danger from fire or explosion is concerned. 2. The Russian petroleum contains much more pure illuminating oil—passing between 150° and 300° C.—and far less heavy oil than American "Standard White." 3. The Russian petroleum is perfectly free from paraffin, hence remains, like the residue from its distillation, fluid at even 20° C., while American "Standard White" becomes dimmed and thick at from 9° to 12° by the paraffin solidifying, and solid at 17·4°. It also contains from 20 to 26 per cent. of heavy paraffinous oil, which at 6° to 8° C. is still solid. 4. The illuminating power of the Russian oil is not inferior to that of the average American "Standard White." The lighter grade of the Russian "White Star" develops a materially higher illuminating power than most of the American oil samples examined. 5. The oil consumption for the same illuminating effect is 14 per cent. less with Russian oil than with American. 6. Notwithstanding the greater height of the flame—0·28 inch from the Russian oil, as against 0·12 to 0·26 inch from the American—from two to three times as much wick is consumed by the American oil as by the Russian.

A highly interesting note by Prof. B. Grassi, on the connection between mosquitoes and malaria, appears in the Atti dei Lincei, says Nature. The theory that these insects disseminate the germs of malaria by their punctures seems to have been first brought into notice by Laveran; but Dr. Grassi for a long time had doubts on the subject, owing to the absence of malaria from certain districts where mosquitoes abound; Schweztingen, in Germany, being a notable instance. A careful classification of the various species of gnat found in different districts has now led him to the conclusion that, while certain kinds are not confined to malarious regions, the distribution of others coincides very closely with the distribution of the disease. The common Culex pipiens is to be regarded as perfectly innocuous: being most abundant in places from which malaria is absent. On the other hand, a large species (Anopheles claviger, Fabr.), known in Italy as "zanzarone," or "moschino," is constantly found associated with malaria, and is most abundant where the disease is most prevalent. In illustration of this fact Dr. Grassi enumertes a number of striking coincidences in which both gnats and the disease are confined to the same limited and well-defined regions. Another disseminator of malaria is Culex penicillaris, and the author gives authentic instances in which recorded punctures of this gnat have been followed by febrile symptoms. Certain other species of Anopheles are confined to the marshy regions where malaria rages, and two or three additional species of Culex are suspected, but on less conclusive evidence. The fact is mentioned that Anopheles claviger confines its attacks chiefly to the evening after sunset, and in this circumstance the old superstition that it is dangerous to fall asleep in malarious regions just after sunset finds a ready explanation. These facts open up new hopes that it may be possible to stamp out malaria by taking proper steps for the destruction of mosquito larvæ in districts where dangerous species abound.

ENGINEERING NOTES.

Experiments on the use of ozone for water purification are described at some length in London Engineering. A briefer and more judicial account of the same experiments is given in the report of the Maine State Board of Health for 1896 and 1897, under "Notes on Disinfectants and Disinfection." The experiments have been made in Germany and Holland during the last six or seven years. Ozone is produced from air by means of high tension electric currents, ranging from 50,000 to 100,000 volts. Thus far the results obtained seem to be of no practical importance, so far as public water supplies are concerned. If the water to be treated with ozone is high in organic matter it is filtered first, at a rate, in some of the experiments, of about 4,000,000 gallons an acre. The ozone seems to be used principally to render the water absolutely sterile, which it apparently does. The expense of the process is not stated.

Acetylene gas for railway carriage lighting has been in use for some time on the Pontiac Pacific Junction Railway, in Canada, says The Engineer. In answer to a request made by Colonel J. H. Western, the inspecting engineer of the Egyptian government railways, for information concerning the use of this gas, Mr. P. W. Resseman, the general superintendent of the former railway, states that he has used it for nine months, and that there is really no comparison between the effectiveness of acetylene gas and coal oil for car lighting. With coal oil at 14 cents per gallon, and carbide at 5 cents per pound, the cost of acetylene gas for car lighting is somewhat less than the same lighting by coal oil. In Canada, however, owing to the severe frost in winter, they have to place the gas generators inside the car to prevent them from freezing. The disadvantage of this lies in the fact that acetylene gas is most difficult to control, and the slightest leak in the generator causes a disagreeable smell in the car. It is found that an ordinary passenger coach, previously lighted by fourteen coal oil burners, can be brilliantly lighted with five 25-candle power burners, consuming each ½ foot per hour. The carbide supplies 5 cubic feet of gas per pound, making the total cost of the lights 2 cents per hour, or for a run of four hours, 20 to 21 cents per car. The gas is generated in small quantities, confined beneath a 7 inch column of water, and any that may escape is so speedily diffused in the surrounding atmosphere that its explosive nature is at once neutralized. In the event of a car turning over, the lights go out immediately, and the gas escapes so quickly that fire cannot affect it.

The work of constructing the projected railway from Moscow to the new port of Windau, which is to replace Libau as a commercial port, is not progressing so quickly as the authorities could desire, says The Engineer. Lately there has been a scarcity of labor on the works of the section running through the northern part of the Baltic province of Courland, and it has become apparent that the natural difficulties to be overcome in that region are much greater than had been anticipated at the outset. It is now reported from Riga that the line planned to run from Tukum in Courland, in a southeasterly direction in the town to Kreuzburg, on the Dwina, in the Russian government of Vitebsk, will form a junction with the Riga line at Mitau, the capital of Courland and due south of the Gulf of Riga. The original project was to take the line via Olai, but as the district of Kalnezeem is so sparsely populated, that direction would have taken the line across many extensive stretches of moorland and swamps, and the cost of construction would have thereby been greatly increased. Moreover, Mitau is a rising town and has already a population of 30,000 inhabitants, while the whole of the immediate neighborhood is strongly populated by a hardworking class of peasants; thus, the new line will open up intercourse in several directions, and the trade of Mitau must in due time be greatly benefited. The river communication between Mitau and Riga offers keen competition with the railway for the conveyance of goods, yet in spite of this the goods traffic at the Mitau Station is continually increasing; a new warehouse has been built at the station and will be brought into communication with the railway. For many years the oil mills at Mitau have carried vast quantities of goods in their huge covered-in cargo boats, which are towed by tug boats along the Aa to Riga, and they have also conveyed imported goods back to Mitau.

In view of the greater facilities that are being afforded in this country to passenger travel, and especially the arrangements made within the last month to run corridor trains to the North, and to give 1,000 mile tickets at reduced rates, it will perhaps interest our readers to know the numbers who travel by railway in continental Europe. Signor Bodio, in a recent report to the Railway Tariffs Committee in Italy, gave the following detailed figures as to the mileage and number of passengers on the principal railways of Europe:

Country.	Mileage.	Number of passengers per annum.	Number of passengers per 100 of the population.
Germany	26,250	483,000,000	978
France	23,750	305,000,000	796
Great Britain and Ireland	20,625	864,000,000	2,282
Russia	18,100	33,000,000	33
Austria	9,375	85,000,000	355
Italy	8,750	51,000,000	171
Hungary	6,850	37,000,000	214
Belgium	2,875	87,000,000	1,426
Switzerland	2,185	37,000,000	1,259
Holland	1,875	33,000,000	726
Roumania	1,500	5,000,000	95

With the exception of Russia and Roumania, Italy has fewer railway passengers per head of the population than any of the other countries, and Signor Bodio adds that, while of the available seating accommodation in trains 35 per cent. is occupied in France, 28 per cent. in Belgium, 27½ per cent. in Switzerland, 27 per cent. in Hungary, and 25 per cent. in Germany, only 23 per cent. is occupied in Italy. There are no statistics of this matter for our own country. Better perhaps for the railway companies that it should be so.—Engineer's Review.

SELECTED FORMULÆ.

Cough Cure.—A combination of sirups of tar and wild cherry is much used as a general cough remedy.

1. Sirup tar	64	fl. ounces.
Sirup wild cherry	45	" "
Sirup squill	16	" "
Deodorized tincture opium	4	" "
Fluid extract lobelia	6	fl. drachms.
Fluid extract ipecac	4	" "
2. Sirup tar	13	fl. ounces.
Sirup tolu	13	" "
Sirup wild cherry	50	" "
Sirup squill	16	" "
Sirup senega	6	" "
Ammonium chloride	3½	av. ounces.
Morphine sulphate	15	grains.
Tartar emetic	30	"
Water	20	fl. ounces.
Glycerin	10	" "

Dissolve the ammonium chloride, morphine sulphate, and tartar emetic in the water, filter the solution, and add the other ingredients.

3. Pine tar	1½	tr. ounces.
Sugar, granulated	24	" "
Diluted alcohol	18	fl. ounces.
Oil anise	20	minims.
Chloroform	1½	fl. ounces.
Fluid extract wild cherry	2½	" "
Fluid extract ipecac	1	" "
Simple sirup, Sirupy glucose, of each		Sufficient.

Triturate the tar with the sugar, add the alcohol, then enough of equal parts of sirup and sirupy glucose to make 66 fluid ounces; add the remaining ingredients, let stand for several hours and strain.

4. Morphine hydrochlorate	3	grains.
Muriatic acid	3	minims.
Fluid extract henbane	2	drachms.
Fluid extract ginger	3	"
Fluid extract wild cherry	3	"
Diluted alcohol	3	"
Chloroform	1	"
Essence of peppermint	30	minims.
Sirup tar	3	ounces.
Simple sirup to make	8	"

—Pharmaceutical Era.

Solutions for stripping the film from negatives, the glass of which may happen to be accidentally broken, are often wanted by amateurs. The following is effective and will strip a film without enlarging it, which is just what is wanted:

Distilled water	500 c. c.
Alcohol	500 "
Glycerin	40 "
Hydrofluoric acid	80 "

In this the negative should be placed till it begins to lift at the corners, then it should be transferred to a dish of clean water, when it can be readily coaxed from the glass with a soft brush, and transferred to a clean glass coated with gelatine. An almost better way is to simply leave the negative in the solution till it begins to lift well at the corners, then remove, squeegee a piece of clean writing paper down on to it, and in a very short time the paper may be lifted and with it the film, and the two squeegeed to a clean glass coated with gelatine, when the paper may be lifted. If the alcohol be omitted from the above, a solution is obtained which is very similar to that put up as a proprietary article for enlarging negatives by extension of the film. If a powder of similar action is required, one may use a mixture of—

Sodium fluoride	120 gm.
Citric acid	240 "

Directing this to be dissolved in 1,000 c. c. of water. It is, of course, needless to point out that the solution given above must be stored in an India rubber bottle, or one well coated inside with paraffin wax.—Pharmaceutical Journal.

Toning Bath.—A new toning bath was recently suggested at one of the London photographic societies for gelatino-chloride paper, the great advantage of which, it was said, was the avoidance of all double toning. It is an open question whether it can actually be called a toning bath in the strictly accepted reading of the words. We have always hitherto accepted as a definition of the word toning the replacement of part of the silver image by gold reduced from the toning solution by the double decomposition of the aurous chloride formed in the bath by the action of the alkaline salt on the auric chloride. In the new bath, which, by the bye, will not keep, the gold is deposited from the bath by the action of the salt formate of soda, and there is no double decomposition. The actual formula recommended is:

Sodium formate	3·5 gm.
Gold chloride	0·25 "
Distilled water	1,000 c. c.
Or,	
Platinum perchloride	0·25 gm.
Sodium formate	7·0 "
Formic acid	1·75 c. c.
Distilled water	1,000 "

The prints must be immersed for five minutes in a 5 per cent. solution of salt and then transferred direct to the toning bath.—Pharmaceutical Journal.

Hæmoglobin and its Preparations.—Pure hæmoglobin is a light to brick-red crystalline powder, which, exposed to the air, darkens a little, due to formation of methæmoglobin. According to Donet, its solubility is 8 to 10 per cent. in water, 10 to 5 per cent. in alcohol, 4 per cent. in white wine, 3 per cent. in red wine. The addition of glycerin increases its solubility. The author gives the following formulæ for pharmaceutical preparations—Vinum hæmoglobini: Hæmoglobin, 30; vini albi, 1,000. A tablespoonful of this wine contains 0·45 gramme of hæmoglobin. Syrupus hæmoglobin: Hæmoglobin, 20, to be suspended in equal parts of cold water. Sirup simpl., 1,000. A tablespoonful contains 0·40 gramme of hæmoglobin. Elixir hæmoglobini: Hæmoglobin, 40 grammes; aquæ destil., 500; syrup. cort. aurant., 400; tinct. cocæ, 100. Pilulæ hæmoglobini: Make a solution of hæmoglobin with the addition of glycerin and water and evaporate to the consistence of an extract. Add excipient and roll out into pills each of which contains 0·1 gramme hæmoglobin. —Pharm. Centralh., xxxviii., 512.

THE ALETHORAMA.

THE principles of the synthesis of motion by photography have been authoritatively set forth by Mr. Marey. It suffices to pass in the focus of a projection objective a series of images that succeed one another through a continuous motion, each image being illuminated only when it is immovable, and the substitution being effected during the period of suppression of the light. Upon the whole, the screen is alternately light and dark. Although, as a consequence of the persistence of luminous impressions upon the retina, the eye has the sensation of a continuous illumination, there nevertheless exists a glare from and dancing of the image that divests it of the stability necessary and produces a true fatigue in the spectator. None of the numerous models of cinematographs (which differ only in the mechanical arrangements employed for obtaining the motion of the film) appears to be free from this imperfection. So it is in an entirely different mode of procedure that we are going to find an original solution of the problem.

The alethorama, devised by Messrs. Mortier and Cheri-Rousseau, is an apparatus designed for taking and projecting cinematographic views. It is based upon a principle entirely different from the one that we have just mentioned. The film, instead of having an interrupted motion, has a continuous one; and the screen, instead of having periods of light and darkness, is illuminated in a permanent manner by the images, which substitute themselves for one another, not in their totality, but in a manner that might be called

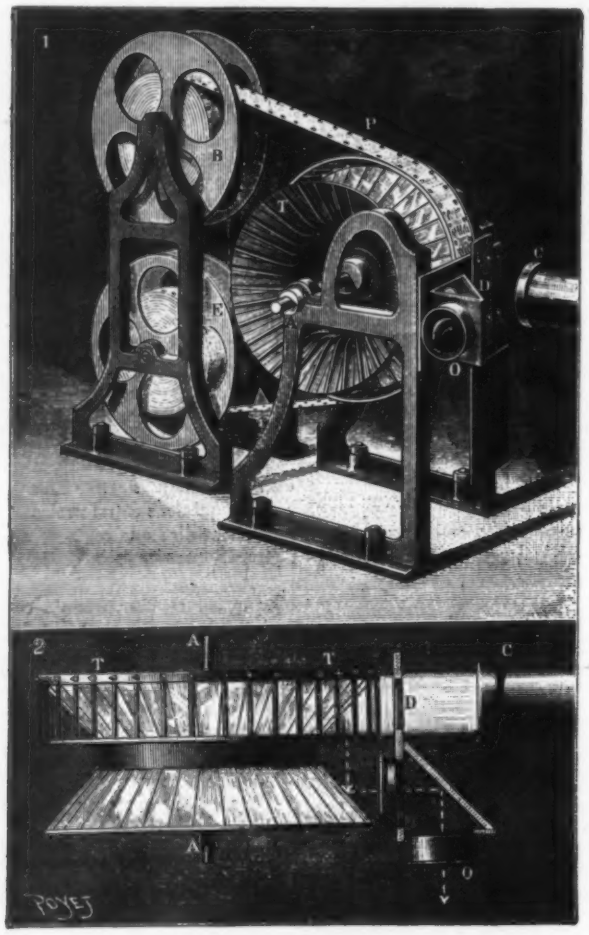


FIG. 1.—THE ALETHORAMA.

1. Arrangement of the apparatus for causing the cinematographic band to pass before a pencil of light. 2. Direction of the rays.

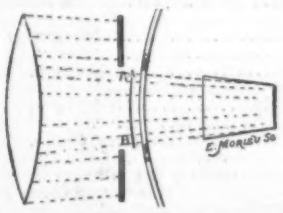


FIG. 2.—Formation of the Image in the Alethorama when an Entire Image is in the Pencil of Light.

complementary and that constitutes the originality of the apparatus.

A metallic drum, *A* (Fig. 1), mounted upon an axle, *T*, is carried along in a rapid rotary motion. Its role is to cause the cinematographic film to pass before an intense pencil of light furnished by an electric arc, *C*.

The film, wound around a bobbin, *B*, passes around another one, *E*, after running over the drum like a transmission belt. It is, on another hand, guided upon the drum by teeth that engage with the perforations. The circumference of the drum over which the film passes is provided with a series of small apertures beneath each image. Concentrically with the surface of the drum there is mounted a series of angular mirrors equal in number to that of the apertures, and inclined at an angle of 90° with respect to each other.

Under such conditions, every negative coming over one of the apertures in the drum will, by virtue of the principle of angular mirrors, give rise to a parallel, rectangular, virtual image reversed with respect to the image that would be produced upon an ordinary single mirror, and one of the axes of symmetry of which exactly coincides with the rotary axis of the system. It follows that while the negative, carried along circularly by the drum, is moving rapidly, its image is, on the contrary, immovable upon the axis. If a projection objective be situated at a proper distance from the axis of the system, the image will appear immovable upon the screen. In reality, this is not wholly the case, for the axis of symmetry of the image which is confounded with the axis of rotation is alone immovable, while the other parts of the image undergo a general rocking motion around the said immovable axis of symmetry. Nevertheless, when the angle of amplitude of the rotary motion is sufficiently feeble and does not exceed say a few degrees, the image, despite its rocking motion, may be considered as practically immovable. No. 2 of Fig. 1 will allow the passage of the rays to be understood perfectly. The pencil of light emanating from the condenser, *C*, traverses the diaphragm, *D* (the role of which we shall see further along), and meets the strip of film applied to the drum at *T T*. The image formed is reflected twice at right angles and falls into the projection objective, which, in turn, sends it to the screen after a new reflection. To this effect, the two lenses of the objective are arranged upon a special mounting, the bottom of which receives a silvered mirror.

The inventors limit the luminous pencil by means of a diaphragm, *D*, so that only a part of the strip of film,

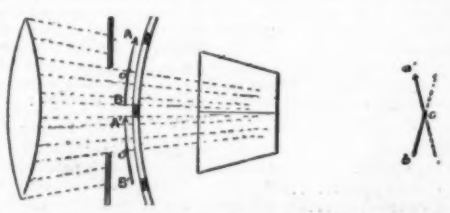


FIG. 3.—Formation of the Complementary Image of the Alethorama when two Portions of Neighboring Images are in the Pencil of Light.

equal to the dimensions of one of the images, shall be lighted. On this account, two cases present themselves: Either the aperture of the drum will be exactly opposite that of the diaphragm,* or else the drum, having continued its motion (Fig. 3), will cause two portions of the neighboring images, *A B* and *A' B'*, to be illuminated. Were the diaphragm sufficiently open to unmask *A B* and *A' B'* simultaneously, we should have two superposed images, *a o b* and *a' o b'*, upon the axis; but since it is intentionally reduced, we shall see upon the screen only the parts, *a' o* and *o b*, each belonging to a different negative, although constituting a single and complete image of the subject represented. The images are therefore replaced in a complementary manner, and not in their totality, as in the cinematograph. This process completely suppresses the scintillation due to the alternate lighting and darkening of the screen. It permits of retarding the passage of the images without its being possible to perceive any interruption.

In this state, the alethorama constitutes a synthetical apparatus which seems to possess genuine advantages over those that have been brought out up to the present. Moreover, since the cinematographic strip is not submitted to an intermittent traction or repeated friction, it is assured of a much longer preservation.

Further, there is nothing to prevent the alethorama from being used as a registering apparatus. To this effect, it would only be necessary to provide it with a special shutter consisting of a drum placed within the one already mentioned. Without entering into theoretical explanations, which would lead us too far, let it suffice to say that in this case the drum would be furnished with narrow slits in number equal to a third of that of the compartments of the principal drum. The shutter drum would be controlled by a train of gearings and revolve three times faster than the principal drum.

In the apparatus that we have described, not only is a perfect sharpness of the images acquired, but there have been obtained with it two results of very great importance—an increase in the number of negatives in a unit of time and great speed in the working of the shutter. It is well known, in fact, that in the cinematograph it is difficult, on account of the stopping and starting of the strip of film, to exceed from fifteen to twenty negatives per second.

Even admitting twenty-five negatives per second, and a disk of which the aperture is a quarter of the circumference, the duration of the exposure will not exceed $\frac{1}{100}$ of a second; and this is absolutely inadequate for an apparatus designed especially for a reproduction of rapid motions. With the alethorama, more than two thousand negatives one inch in height can be made to pass per second.

Finally, the continuous motion of the film permits of increasing the size of the primary images without any difficulty. There is here likewise an interesting point, for the small size of the images prevents the obtaining of adequate projections, because of the too great enlargement that must be employed.

As may be seen from the above brief description, Messrs. Mortier and Cheri-Rousseau's ingenious apparatus opens up a new field for cinematography, which, since its origin, has made no appreciable progress.—La Nature.

* This is the case represented in Fig. 2. The image, *A B*, illuminated in its totality, will form upon the axis at *a o b* and be visible upon the screen in its entirety.

CAUSE OF BRIGHTNESS IN WELSBACH MANTLES.

A NUMBER of theories have been proposed to account for the incandescent properties of mantles, all of which have their adherents and dissenters. The more cautious state the phenomenon as being a property, and go no further. There are others, however, who claim a catalytic action, or say it is due to high temperature, or due to a phase of combustion, and so on, until the humble student scarcely knows whether he really knows what he does know. And then, again, it is claimed that the incandescent oxides possess the property of altering the wave line of light, a theory advanced first by Nichols and Snow to explain the incandescence of oxide of zinc. Le Chatelier and O. Boudard, in the Comptes Rendus, have lately given the results of their investigations in this direction, claiming that the light is confined principally to the region of the spectrum, i. e., between red and blue, the luminous yield varying with the color and the temperature. In experimenting with various substances, by placing them upon the electric pyrometer in the flame, and comparing the results obtained with the luminous intensity of melting platinum, they obtained the following results:

Incandescent substance.	Temperature. Deg. Cent.	Relative luminous intensity. Red.	Green.	Blue.
Platinum.....	1,290	0·085	0·040	0·044
Ferric oxide.....	1,080	0·015	0·0048	0·001
Auer mantle.....	1,380	0·070	0·125	0·125
Thorium oxide....	1,290	0·0145	0·014	0·003
Cerium oxide	1,110	0·019	0·007	0·015
Uranium oxide....	1,070	0·003	0·0015	0·0005
Lanthanum oxide..	1,250	0·040	0·031	0·018

These temperatures are much below those sometimes claimed. Bunte, for example, claiming about 2,000° Cent. The authors state that at a given temperature the brilliancy is the same whether the incandescent substance is heated in the burning gases or in the hot gases already burned. The temperature required for incandescence is not much above that of the incandescent particles in an ordinary gas flame, or, in round numbers, about 1,650° Cent. (3,000° Fah.) To determine this temperature, the light from an Auer mantle was compared with a portion of the same material placed on the couple of the electric pyrometer. The following were the results obtained:

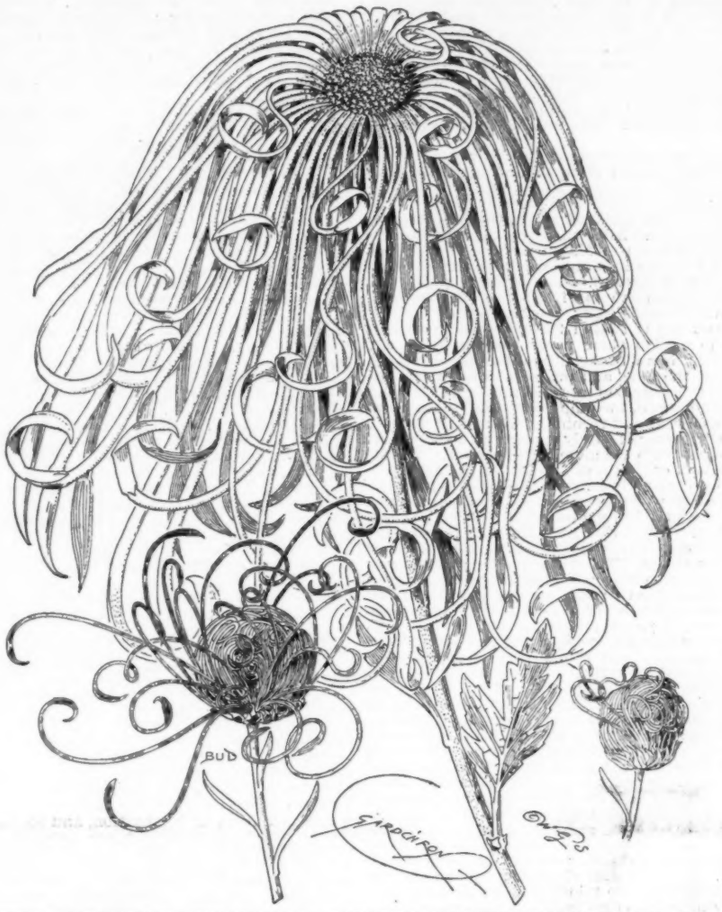
Material.	Temperature. Deg. Cent.	Relative luminous intensity. Red.	Green.	Blue.
Mantle.....	...to be found.	0·23	0·42	0·41
Coating on thermo-couple....	1,100	0·0023	0·0017	0·0013
	1,300	0·019	0·031	0·020
	1,500	0·140	0·280	0·170
	1,700	0·350	0·780	0·400

By comparison, therefore, it will be seen that the temperature of the mantle must have varied between 1,590° Cent. and 1,710° Cent., depending upon the color of radiation utilized. They conclude as follows: "The mantle is composed of a material of which the emissive power at its working temperature differs for its different radiations, and is, hence, at least at this temperature, what is called a colored body. Its good yield results from its great emissive power being in the neighborhood of unity near blue, green, and yellow, and much less for red, and probably still less for infra red. The proportion of radiated energy which is visible is, therefore, very great."

THE CHRYSANTHEMUM "WHAT HO!"

"WHAT HO!" has long, drooping, tubular ray-florets that curl at the tips; and it is curious to note from the illustration of the buds given that this characteristic is quite evident immediately the florets emerge from the flower head, and before they have acquired a fifth part of their length.

In "What Ho!" the florets are long tubes, some spreading at right angles, others more or less pendulous. The exigencies of our space have compelled the artist to show more of the latter than of the former. But the curious point botanically is, that the receptacle is quite devoid of the bracts. The presence or the absence of these bracts will probably not be noticed by the ordinary cultivator, unless his attention be drawn to it, but for the botanist these peculiarities will be considered as of greater importance than the variation in the form of the corollas. There is apparently considerable variation in the size of these bracts in different varieties.—The Gardeners' Chronicle.



CHRYSANTHEMUM "WHAT HO!"—COLOR OF FLOWER YELLOW AND RED.

THE ELEPHANT IN INDIA.

THE elephant in India is such a useful servant that even the railways have special facilities for transporting elephants from one part of the country to another. The cars in which they are carried are built either of wood or iron and resemble an ordinary coal car with a huge crate on top. The central panel of the sides of the car drop down and form an inclined walk by which the elephant enters or leaves the car. It is curious to watch the elephants enter their conveyance. A rope is fastened to one of the elephant's forelegs and a number of natives haul on this rope, and a tame elephant, which has not been denuded of his tusks, assists the elephant in the rear, nudging him with his tusks. The elephant tests the hinged door of the car carefully before he will consent to have himself pulled and prodded into it. As might be expected, the elephants which are new to captivity are greatly afraid of the railway, and they rend the air with their trumpetings. The cars are built of old rails and effectually prevent the elephants from injuring either themselves or the railway servants.

When the elephants are to be transported by sea, they are secured by a strong sling and are lowered onto a raft to be conveyed to a steamer. Elephants are splendid swimmers and will swim for six or eight miles without rest. When the steamer is reached, the elephants are hauled up over the side with the aid of the sling and a hoisting engine. It is no simple task to transport these huge beasts, as they weigh almost three tons. There has been much exaggeration of the stories of the height of the Indian elephant. The largest elephant which has been measured in the flesh was 10 feet 7½ inches high at the shoulder. An elephant will carry its own food for a long time. Our engraving shows an elephant carrying a Palmyra palm to eat at its leisure. For our engravings and the foregoing particulars we are indebted to The London Graphic.

A SHORT HISTORY OF SCIENTIFIC INSTRUCTION.*

I.

THE two addresses by my colleagues Profs. Judd and Roberts-Austen have drawn attention to the general history of our college and the details of one part of our organization. I propose to deal with another part, the consideration of which is of very great importance at the present time, for we are in one of those educational movements which spring up from time to time and mould the progress of civilization. The question of a teaching university in the largest city in the world, secondary education, and so-called technical education are now occupying men's minds.

At the beginning it is imperative that I should call your attention to the fact that the stern necessities of the human race have been the origin of all branches of science and learning; that all so-called educational movements have been based upon the actual requirements of the time. There has never been an educational movement for learning's sake; but of course there have always been studies and students apart from any of those general movements to which I am calling attention; still we have to come down to the times of Louis Quatorze before the study of the useless, the même inutile, was recognized as a matter of national concern.

It is perhaps the more necessary to insist upon stern necessity as being the origin of learning, because it is so difficult for us now to put ourselves in the place of those early representatives of our race that had to face the problems of life among conditionings of which they were profoundly ignorant; when night meant death; when there was no certainty that the sun would rise on the morrow; when the growth of a plant from seed was unrecognized; when a yearly return of seasons might as well be a miracle as a proof of a settled order of phenomena; when, finally, neither cause nor effect had been traced in the operations of nature.

It is doubtless in consequence of this difficulty that some of the early races have been credited by some authors with a special love of abstract science, of science for its own sake; so that this, and not stern necessity, was the motive of their inquiries. Thus we have been told that the Chaldæans differed from the other early races in having a predilection for astronomy, another determining factor being that the vast plains in that country provided them with a perfect horizon.

The first historic glimpses of the study of astronomy we find among the peoples occupying the Nile Valley and Chaldæa, say 6000 B. C.

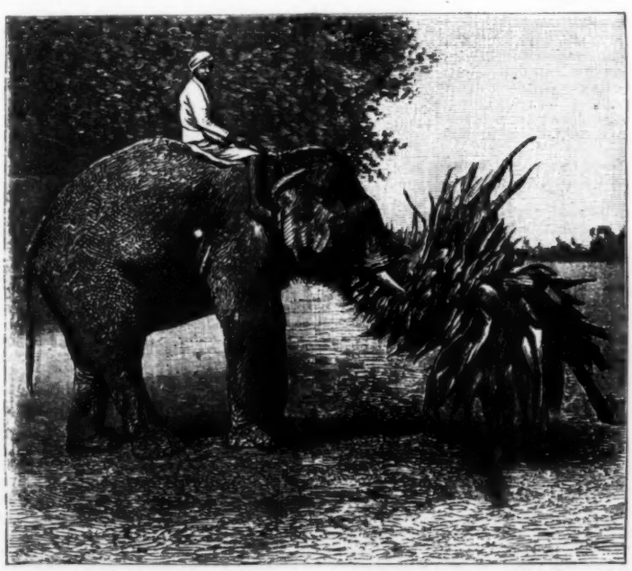
But this study had to do with the fixing of the length of the year, and the determination of those times in it in which the various agricultural operations had to be performed. These were related strictly to the rise of the Nile in one country and of the Euphrates in the other. All human activity was in fact tied up with the movements of the sun, moon, and stars. These, then, became the gods of those early peoples, and the astronomers, the seers, were the first priests; revered by the people because as interpreters of the celestial powers they were the custodians of the knowledge which was the most necessary for the purposes of life.

Eudemus of Rhodes, one of the principal pupils of Aristotle, in his History of Geometry, attributes the origin of geometry to the Egyptians, "who were obliged to invent it in order to restore the landmarks which had been destroyed by the inundation of the Nile," and observes that "it is by no means strange that the invention of the sciences should have originated in practical needs."† The new geometry was brought from Egypt to Greece by Thales three hundred years before Aristotle was born.

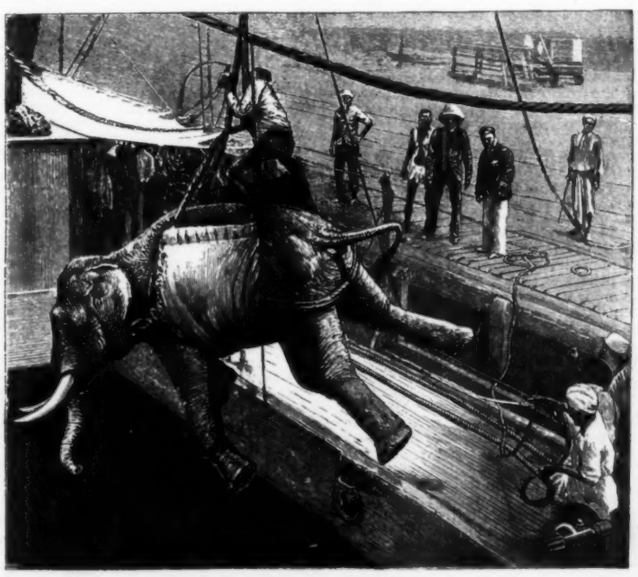
When to astronomy and geometry we add the elements of medicine and surgery, which it is known were familiar to the ancient Egyptians, it will be conceded

*An address delivered at the Royal College of Science by Sir Norman Lockyer, K.C.B., F.R.S., on October 6.

†"Greek Geometry from Thales to Euclid," p. 2. (Allman.)



ELEPHANT TAKING A PALMYRA PALM HOME FOR DINNER.



SLINGING AN ELEPHANT.

that we are, in those early times, face to face with the cultivation of the most useful branches of science.

Now, although the evidence is increasing day by day that Greek science was Egyptian in its origin, there is no doubt that its cultivation in Greece was more extended, and that it was largely developed there. One of the most useful and prolific writers on philosophy and science who has ever lived, Aristotle, was born in the fourth century B. C. From him, it may be said, dates a general conception of science based on observation as differing from experiment. If you wish to get an idea of the science of those times, read his writings on Physics and on the Classification of Animals. All sought in Aristotle the basis of knowledge, but they only read his philosophy; Dante calls him "the master of those who know."*

Why was Aristotle so careful to treat science as well as philosophy, with which his master, Plato, had dealt almost exclusively?

The answer to this question is of great interest to our present subject. The late Lord Playfair,† in a pregnant passage, suggests the reason, and the later history of Europe shows, I think, that he is right.

"We find that just as early nations became rich and prosperous, so did philosophy arise among them, and it declined with the decadence of material prosperity. In those splendid days of Greece when Plato, Aristotle, and Zeno were the representatives of great schools of thought, which still exercise their influence on mankind, Greece was a great manufacturing and mercantile community; Corinth was the seat of the manufacture of hardware; Athens that of jewelry, shipbuilding, and pottery. The rich men of Greece and all its free citizens were actively engaged in trade and commerce. The learned class were the sons of those citizens, and were in possession of their accumulated experience derived through industry and foreign relations. Thales was an oil merchant; Aristotle inherited wealth from his father, who was a physician, but, spending it, is believed to have supported himself as a druggist till Philip appointed him tutor to Alexander. Plato's wealth was largely derived from commerce, and his master, Socrates, is said to have been a sculptor. Zeno, too, was a traveling merchant. Archimedes is perhaps an exception, for he is said to have been closely related to a prince; but if so, he is the only princely discoverer of science on record."

In ancient Greece we see the flood of the first great intellectual tide. Alas! it never touched the shores of Western Europe, but it undoubtedly reached Rome, and there must have been very much more observational science taught in the Roman studia than we generally imagine, otherwise how account for Pliny, the vast public works, their civilizing influence carried over sea and land from beyond Bab-el-Mandeb to Scotland? In some directions their applications of science are as yet unsurpassed.

With the fall of the Roman Empire both science and philosophy disappeared for a while. The first wave had come and gone; its last feebler ripples seem to have been represented at this time by the gradual change of the Roman secular studia wherever they existed into clerical schools, the more important of which were in time attached to the chief cathedrals and monasteries; and it is not difficult to understand why the secular (or scientific) instruction was gradually replaced by one more fitted for the training of priests.

It is not to be wondered at that the ceaseless strife in the center of Europe had driven what little learning there was to the Western and Southern extremities, where the turmoil was less—I refer to Britain and South Italy—while the exiled Nestorians carried Hellenic science and philosophy out of Europe altogether to Mesopotamia and Arabia.

The next wave, it was but a small one, had its origin in our own country. In the eighth century England was at its greatest height, relatively, in educational matters, chiefly owing to the labors of two men. Beda, generally called the Venerable Bede, the most eminent writer of his age, was born near Monkwearmouth in 673, and passed his life in the monastery there. He not only wrote the history of our island and nation, but treatises on the nature of things, astronomy, chronology, arithmetic, medicine, philosophy, grammar, rhetoric, poetry, music, basing his work on that of Pliny. He died in 735, in which year his great follower was born in Yorkshire. I refer to Alcuin. He was educated at the Cathedral School at York under Archbishop Egbert, and having imbibed everything he could learn from the writings of Bede and others, was soon recognized as one of the greatest scholars of the time. On returning from Rome, whither he had been sent by Eaubald to receive the pallium, he met Karl the Great, King of the Franks and Lombards, who eventually induced him to take up his residence at his Court to become his instructor in the sciences. Karl (or Charlemagne) then was the greatest figure in the world, and although as King of the Franks and Lombards, and subsequently Emperor of the Holy Roman Empire, his Court was generally at Aachen, he was constantly traveling throughout his dominions. He was induced, in consequence of Alcuin's influence, not only to have a school always about him on his journeys, but to establish or foster such schools wherever he went. Hence it has been affirmed that "France is indebted to Alcuin for all the polite learning it boasted of in that and the following ages."

The Universities of Paris, Tours, Fulden, Soissons, and others were not actually founded in his day, but the monastic and cathedral schools out of which they eventually sprung were strengthened, and indeed a considerable scheme of education for priests was established; that is, an education free from all sciences, and in which philosophy alone was considered.

Karl the Great died in 814, and after his death the eastward-traveling wave, thus started by Bede and Alcuin, slightly but very gradually increased in height. Two centuries later, however, the conditions were changed. We find ourselves in presence of interference phenomena, for then there was a meeting with another wave traveling westward, and this meeting was the origin of the European universities. The wave now manifested traveling westerly, spread outward from Arab centers first and finally from Constantinople, when its vast stores of Greek lore were opened by the conquest of the city.

* "Inferno," c. iv. 130 et seq.

† "Subjects of Social Welfare," p. 206.

The first wavelet justified Eudemus' generalization that "the invention of the sciences originated in practical needs," and that knowledge for its own sake was not the determining factor. The year had been determined, stone circles erected almost everywhere, and fires signaled from them, giving notice of the longest and shortest days, so that agriculture was provided for, even away from churches and the festivals of the church.

The original user of geometry was not required away from the valleys of the Nile, Tigris, and Euphrates, and, therefore, it is now medicine and surgery that come to the front for the alleviation of human ills. In the eleventh century we find Salerno, soon to be famed throughout Europe as the great medical school, forming itself into the first university. And medicine did not exhaust all the science taught, for Adelard listened there to a lecture on "the nature of things," the cause of magnetic attraction being one of the "things" in question.

This teaching at Salerno preceded by many years the study of the law at Bologna and of theology at Paris.

The full flood came from the disturbance of the Arab wave center by the crusades, about the beginning of the twelfth century. After the Pope had declared the "Holy War," William of Malmesbury tells us, "The most distant islands and savage countries were inspired with this ardent passion. The Welshman left his hunting, the Scotchman his fellowship with vermin, the Dane his drinking party, the Norwegian his raw fish." Report has it that in 1096 no less than six millions were in motion along many roads to Palestine. This, no doubt, is an exaggeration, but it reflects the excitement of the time, and prepares us for what happened when the crusaders returned; as Green puts it,* "the western nations, including our own, were quickened with a new life and throbbing with a new energy. . . . . A new fervor of study sprang up in the West from its contact with the more cultured East. Travelers like Adelard, of Bath, brought back the first rudiments of physical and mathematical science from the schools of Cordova or Bagdad. . . . The long mental inactivity of feudal Europe broke up like ice before a summer's sun. Wandering teachers, such as Lanfranc or Anselm, crossed sea and land to spread the new power of knowledge. The same spirit of restlessness, of inquiry, of impatience with the older traditions of mankind, either local or intellectual, that drove half Christendom to the tomb of its Lord, crowded the roads with thousands of young scholars hurrying to the chosen seats where teachers were gathered together."

Studium generale was the term first applied to a large educational center where there was a guild of masters, and whither students flocked from all parts. At the beginning of the thirteenth century the three principal studia were Paris, Bologna and Salerno, where theology and arts, law and medicine, and medicine almost by itself, were taught respectively; these eventually developed into the first universities.†

English scholars gathered in thousands at Paris round the chairs of William of Champeaux or Abelard, where they took their place as one of the "nations" of which the great middle age University of Paris was composed.

We have only to do with the Arts faculty of this University. We find that the subject matter of the liberal education of the middle age there dealt with varied very little from that taught in the schools of ancient Rome.

The so-called "artiens," students of the Arts faculty, which was the glory of the University and the one most numerously attended, studied the seven arts of the trivium and quadrivium—that is, grammar, rhetoric, dialectic and arithmetic, geometry, music, astronomy.‡

This at first looks well for scientific study, but the mathematics taught had much to do with magic; arithmetic dealt with epacts, golden numbers, and the like. There was no algebra, and no mechanics. Astronomy dealt with the system of the seven heavens.

Science, indeed, was the last thing to be considered in the theological and legal studia, and it would appear that it was kept alive more in the medical schools than in the Arts faculties. Aristotle's writings on physics, biology, and astronomy were not known till about 1230, and then in the shape of Arab-Latin translations. Still it must not be forgotten that Dante learned some of his astronomy, at all events, at Paris.

Oxford was an offshoot of Paris, and therefore a theological studium, in all probability founded about 1167,§ and Cambridge came later.

Not till the Reformation (sixteenth century) do we see any sign of a new educational wave, and then we find the two which have had the greatest influence upon the history of the world—one of them depending upon the Reformation itself, the other depending upon the birth of experimental inquiry.

Before the Reformation the Universities were priestly institutions, and derived their authority from the Popes.

The Universities were for the few; the education of the people, except in the various crafts, was unprovided for.

The idea of a general education in secular subjects at the expense of the State or of communities is coeval with the Reformation. In Germany, even before the time of Luther, it was undreamt of, or rather, perhaps, one should say, the question was decided in the negative. In his day, however, his zeal first made itself heard in favor of education, as many are now making themselves heard in favor of a better education, and in 1524 he addressed a letter to the Councils of all the towns in Germany, begging them to vote money not merely for roads, dikes, guns, and the like, but for schoolmasters, so that all children might be taught; and he states his opinion that if it be the duty of a State to compel the able bodied to carry arms, it is à fortiori its duty to compel its subjects to send their children to school, and to provide schools for those who without such aid would remain uninstructed.

Here we have the germ of Germany's position at the present day, not only in scientific instruction but in everything which that instruction brings with it.

* "History of the English People," i. 198.

† See "Histoire de l'Université de Paris." Crévier, 1791, passim.

‡ Enumerated in the following middle age Latin verse:
"Lingua, tropus, ratio, numerus, tonus, angulus, astra."

§ "Universities of Europe in the Middle Ages," Rashdall, vol. ii., p. 344.

With the Reformation this idea spread to France. In 1560 we find the States General of Orleans suggesting to Francis II. a "levée d'une contribution sur les bénéfices ecclésiastiques pour raisonablement stipendier des pédagogues et gens lettrés, en toutes villes et villages, pour l'instruction de la pauvre jeunesse du plat pays, et soient tenus les pères et mères, à peine d'amende, à envoyer les dits enfants à l'école, et à ce faire soient contraints par les segnieurs et les juges ordinaires."

Two years after this suggestion, however, the religious wars broke out; the material interests of the clerical party had predominated, the new spirit was crushed under the iron heel of priestcraft, and the French, in consequence, had to wait for three centuries and a revolution before they could get comparatively free.

In the Universities, or at all events alongside them, we find next the introduction, not so much yet of science, as we now know it, with its experimental side, as of the scientific spirit.

The history of the Collége de France, founded in 1531, by Francis the First, is of extreme interest. In the fifteenth century, the studies were chiefly literary, and except in the case of a few minds they were confined merely to scholastic subtleties, taught (I have it on the authority of the Statistique de l'Enseignement Supérieur) in barbarous Latin. This was the result of the teaching of the faculties; but even then, outside the faculties, which were immutable, a small number of distinguished men still occupied themselves in a less rigid way in investigation: but still these studies were chiefly literary. Among those men may be mentioned Danès, Postel, Dole, Guillaume Budé, Lefèvre d'Etaples, and others, who edited with notes and commentaries Greek and Latin authors whom the University scarcely knew by name. Hence the renaissance of the sixteenth century, which gave birth to the Collége de France, the function of which, at the commencement, was to teach those things which were not in the ordinary curriculum of the faculties. It was called the Collége des Deux Langues, the languages being Hebrew and Greek. It then became the Collége des Trois Langues, when the king, notwithstanding the opposition of the University, created in 1534 a chair of Latin. There was another objection made by the University to the new creation: from the commencement the courses were free; and this feeling was not decreased by the fact that around the celebrated masters of the Trois Langues a crowd of students were soon congregated.

The idea in the mind of Francis the First in creating this Royal College may be gathered from the following edict, dated in 1545: "François, etc., savoir faisons à tous présents et à venir que Nous, considérant que le sçavoir des langues, qui est un des dons du Saint-Esprit, fait ouverture et donne le moyen de plus entière connaissance et plus parfaite intelligence de toutes bonnes, honnêtes, saintes et salutaires sciences. . . . Avons fait faire pleinement entendre à ceux qui, y voudraient vacquer, les trois langues principales, Hébraïque, Grecque, et Latine, et les Livres esquels les bonnes sciences sont le mieux et le plus profondément traitées. A laquelle fin, et en suivant le décret du concile de Vienne, nous avons piéça ordonné et establi en nôtre bonne ville de Paris, un bonne nombre de personnages de sçavoir excellent, qui lisent et enseignent publiquement et ordinairement les dites langues et sciences, maintenant florissant autant ou plus qu' elles ne firent de bien longtemps. . . . auxquels nos lecteurs avons donné honnêtes gages et salaires, et iceux fait pourvoir de plusieurs beaux bénéfices pour les entretenir et donner occasion de mieux et plus continuellement entendre au fait de leur charge. . . . etc."

The Statistique, which I am following in this account, thus sums up the founder's intention: "Le Collége Royal avait pour mission de propager les nouvelles connaissances, les nouvelles découvertes. Il n'enseignait pas la science faite, il la faisait."

It was on account of this, more than on account of anything else, that it found its greatest enemy in the University. The founding of this new college and the great excitement its success occasioned in Paris were, there can be little doubt, among the factors which induced Gresham to found his college in London in 1574.

These two institutions played a great part in their time. Gresham College, it is true, was subsequently strangled, but not before its influence had been such as to permit the Royal Society to rise phœnix-like from its ashes, for it is on record that the first step in the forming of this society was taken after a lecture on astronomy by Sir Christopher Wren at the College. All connected with them felt in time the stupendous change of thought in the century which saw the birth of Bacon, Galileo, Gilbert, Hervey, Tycho Brahe, Descartes, and many others that might be named; and of these, it is well to remark, Gilbert,* Hervey, and Galileo were educated in medical schools abroad.

Bacon was not only the first to lay down regulæ philosophandi, but he insisted upon the far-reaching results of research, not forgetting to point out that "lucifera experimenta, non fructifera quærenda,"† as a caution to the investigator, though he had no doubt as to the revolution about to be brought about by the ultimate application of the results of physical inquiry.

As early as 1560 the Academia Secretorum Naturæ was founded at Naples, to be followed by the Lincei in 1609, the Royal Society in 1645, the Cimento in 1657, and the Paris Academy in 1666.

From that time the world may be said to have belonged to science, now no longer based merely on observation, but on experiment. But, alas! how slowly has it percolated into our universities.

The first organized endeavor to teach science in schools was naturally made in Germany (Prussia), where, in 1747 (nearly a century and a half ago), Realschulen were first started; they were taken over by the government in 1832, and completely reorganized in 1859, this step being demanded by the growth of industry and the spread of the modern spirit. Eleven hours a week were given to natural science in these schools forty years ago.

TEACHING THE TEACHERS.

Until the year 1762 the Jesuits had the education of

* "William Gilbert, of Colchester, on the Magnet." Mitteiag, p. x.

† "Nov. Org.," i. 70. Fowler's Edition, p. 255.

France almost entirely in their hands, and when, therefore, their expulsion was decreed in that year, it was only a necessary step to create an institution to teach the future teachers of France. Here, then, we had the Ecole Normale in theory; but it was a long time before this theory was carried into practice, and very probably it would never have been had not Rolland d'Erceville made it his duty, for more than twenty years, by numerous publications, among which is especially to be mentioned his "Plan d'Education," printed in 1783, to point out not merely the utility, but the absolute necessity for some institution of the kind. As generally happens in such cases, this exertion was not lost, for, in 1794, it was decreed that an Ecole Normale should be opened at Paris, "ou seront appelés de toutes les parties de la République, des citoyens déjà instruits dans les sciences utiles, pour apprendre, sous les professeurs les plus habiles dans tous les genres, l'art d'enseigner."

To follow these courses in the art of teaching, one potential schoolmaster was to be sent to Paris by every district containing 20,000 inhabitants; 1,400 or 1,500 young men, therefore, arrived in Paris, and in 1795 the courses of the school were open first of all in the amphitheater of the Museum of Natural History. The professors were chosen from among the most celebrated men of France, the sciences being represented by Lagrange, Laplace, Hatiry, Monge, Daubenton, and Berthollet.

While there was this enormous progress abroad, represented especially by the teaching of science in Germany and the teaching of the teachers in France, things slumbered and slept in Britain. We had our coal and our iron, our material capital, and no one troubled about our mental capital—least of all the universities, which had become, according to Matthew Arnold (who was not likely to overstate matters), mere hauts lycées, and "had lost the very idea of a real university,"* and since our political leaders generally came from the universities, little more was to be expected from them.

Many who have attempted to deal with the history of education have failed to give sufficient prominence to the tremendous difference there must necessarily have been in scientific requirements before and after the introduction of steam power.

It is to the discredit of our country that we who gave the perfected steam engine, the iron ship, and the locomotive to the world, should have been the last to feel the next wave of intellectual progress.

All we did at the beginning of the century was to found mechanics' institutions. They knew better in Prussia, "a bleeding and lacerated mass,"† after Jena (1806), King Frederic William III. and his councilors, disciples of Kant, founded the University of Berlin, "to supply the loss of territory by intellectual effort." Among the universal poverty money was found for the Universities of Koenigsberg and Breslau, and Bonn was founded in 1818. As a result of this policy, carried on persistently and continuously by successive ministers, aided by wise councilors, many of them the products of this policy, such a state of things was brought about that not many years ago M. Ferdinand Lot, one of the most distinguished educationists of France, accorded to Germany a "supremacy in Science comparable to the supremacy of England at sea."

But this position has not been obtained merely by founding new universities. To Germany we owe the perfecting of the methods of teaching Science.

I have shown that it was in Germany that we find the first organized science teaching in schools. About the year 1825 that country made another tremendous stride. Liebig demonstrated that science teaching, to be of value, whether in the school or the university, must consist to a greater or less extent in practical work, and the more the better; that book work was next to useless.

Liebig, when appointed to Giessen, smarting still under the difficulties he had had in learning chemistry without proper appliances, induced the Darmstadt government to build a chemical laboratory in which the students could receive a thorough practical training.

It will have been gathered from this reference to Liebig's system of teaching chemistry, that still another branch of applied science had been created, which has since had a stupendous effect upon industry; and while Liebig was working at Giessen, another important industry was being created in England. I refer to the electric telegraph and all its developments, foreshadowed by Galileo in his reference to the "sympathy of magnetic needles."

Not only then in chemistry, but in all branches of science which can be applied to the wants of man, the teaching must be practical—that is, the student must experiment and observe for himself, and he must himself seek new truths.

It was at last recognized that a student could no more learn Science effectively by seeing some one else perform an experiment than he could learn to draw effectually by seeing some one else make a sketch. Hence in the German Universities the Doctor's degree is based upon a research.

Liebig's was the fons et origo of all our laboratories—mechanical, metallurgical, chemical, physical, geological, astronomical, and biological.

J. NORMAN LOCKYER.

(To be continued.)

A TALLOW LAMP FOR GLASS BLOWING AND OTHER BLOWPIPE WORK.

By THOMAS BOLAS, F.C.S., F.I.C.

BEFORE coal gas came into use, glass blowers used a lamp containing tallow or other fatty fuel, and after a long period of almost complete disuse, such lamps are once more becoming important, electric lighting having replaced gas in so many houses and public buildings.

The chief disadvantages of the old forms of tallow lamp having one large wick of soft cotton are as follows: 1. A flame with a very large hollow is obtained, and the partially vaporized and decomposed tallow contained in the large hollow tends to blow out sideways, and give a ragged reducing flame. 2. There is a rapid burning away of the wick at the edges; this necessitating trimming and involving considerable and troublesome variations in the character of the flame. 3. The flame cannot be regulated rapidly, especially as to its fitness to furnish a small or large blowpipe flame as required.

The above disadvantages of the tallow lamp all disappear in the case of the form described below. The new form gives a blowpipe flame fully equal to the best gas blowpipe flame; and the lamp, being once adjusted to the character of the flame required, will remain constant for half an hour or more.

The new tallow lamp consists merely of a tin plate tray open at the top, 1 inch deep, 1⅝ inches wide, and 3½ inches long, through the bottom of which five flat air shafts ⅛ × ⅜ inch rise, and these air shafts terminate level with the top of the tray; so that if one looks

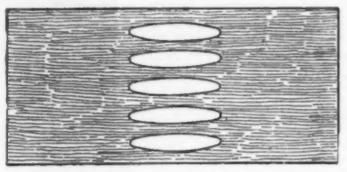


Fig. I.

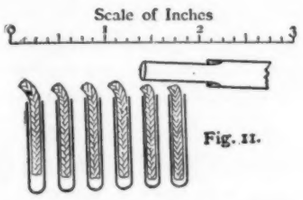


Fig. II.

downward on the lamp, it appears as shown by Fig. I. The tray being filled with tallow (or any fat oil may be used), pieces of the compact cotton wick used for mineral oil lamps, and cut to a length of 1 inch, are placed between the air shafts and lighted. Naturally one large flame is formed; but the air rising through the shafts so breaks up the central hollow, and so far brings the combustion into a smaller area, that little difficulty is found in so adjusting the air jet or blast as to obtain a good blowpipe flame, and the hard wicks, being well within the flame, scarcely suffer after many hours use. The soft wick ordinarily found to be essential for use with the tallow lamp is undesirable in this case.

Fig. II. shows the approximate position of the six wicks (1 inch wide) and air jet which are used when we require the largest blowpipe flame which can be maintained by one person's blowing: the air jet in this case being nearly a quarter of an inch in diameter; but for smaller flames fewer and narrower wicks should be used. For example, an air jet one twenty-fifth of an inch in diameter will require three wicks, each wick being one-fourth of an inch wide. The spaces between the air shafts are so wide as to allow the wick—as ordinarily used for mineral oil lamps—to be easily removed or changed by a small pair of tweezers, but so close as to hinder any tendency to shift and disturb the adjustment. A slight adjustment of one wick or more can be made with the tweezers instantly and while the blast is maintained, so the adaptation of the fuel to the air becomes almost as easy as with coal gas and a stopcock. It will be remarked that the lamp body which I recommend is very small, and this necessitates the frequent dropping of fresh lumps of fuel into the open ends of the lamp body, a matter of no inconvenience when solid paraffin or wax is used and the material is at hand in small lumps. Tallow is ideal as far as the character of flame is concerned, but it is messy to handle, and productive of smoke and smell. Paraffin wax and white beeswax are open to neither of these objections, and can be used in any house, or even drawing room, without inconvenience.

The lamp, as I have made it, stands in an outer tin plate tray about a foot square, and the bottom of the lamp is an inch and a half or so above the tray. The front of the tray carries the air jet with universal motions for adjustment, and a plain cover fitting loosely over the lamp serves not only as a general extinguisher but also to extinguish any burning wicks which may be taken out of the lamp and laid on the tray. I find it convenient never to trim the wicks, but to soak the stock of wick in paraffin wax, and then cut it into 1-inch lengths; replacement of an old wick by a new one being far quicker and more convenient than trimming. As before mentioned, the wicks last a long time, and in practice they are more often changed (one at a time, and while the lamp is burning) to suit a new air jet, than because hardened or charred at the top; and the wick material is so cheap that it is scarcely worth while to put back a wick that has been once used.

For flames considerably inclined upward or downward, the lamp may be trunnioned at the ends; but a tilt of about 15° is the utmost practicable, as in this case the highest wick would be at least half out of the liquid fuel. Longitudinal division at the second and fourth airshafts will make the tilted lamp like a canal divided into three locks, and now a tilt of over 45° can be given without inconvenience. Adaptations of this kind are so obvious as scarcely to require mention.

Paraffin wax of low melting is better than the more expensive kinds which melt at a high temperature, and in practice it is often convenient to purchase the cheapest paraffin candles, to split them longitudinally, tear out the wicks, and to break the material into lengths of about an inch.—From the Journal of the Society of Arts.

THE WYDTS-ROCHEFORT TRANSFORMER.

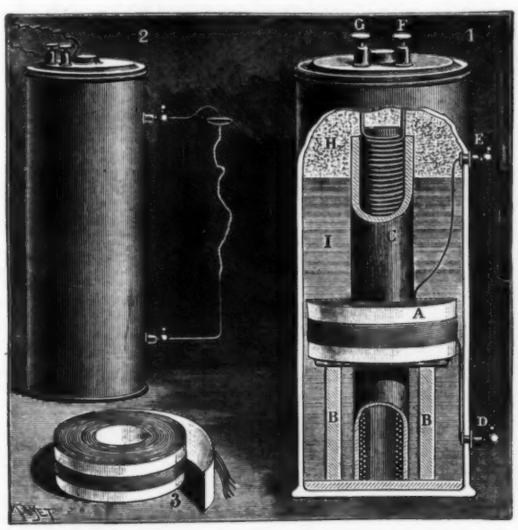
WITHIN recent years the Ruhmkorff coil has been considerably modified with a view to supplying apparatus for the production of Roentgen rays and currents of great frequency. After various changes, the coils have finally been made to give sparks of from 12 to 14 inches in length, but have often presented drawbacks in their operation, while the induced wire has been exposed to rapid destruction.

Messrs. Wydts & Rochefort have succeeded in constructing a transformer which has special arrangements that permit of obtaining large sparks. In the annexed figure No. 1 shows an internal section of the apparatus. In the center of a large cylindrical glass vessel is placed a soft iron core, around which is wound a double layer of insulated coarse copper wire, the extremities of which end at the external terminals, *F* and *G*. This circuit constitutes an inductor, which is inclosed in an insulating tube, *C*. Pieces of wood, *B B*, at the bottom of the vessel support the induced bobbin, *A*.

The coil, shown in No. 3 of the figure, consists solely of fine insulated wire wound around a special insulating band of paper that is wound at the same time. A coil includes about 25 ounces of fine wire 0·006 of an inch in diameter. It is placed at *A*, and the two extremities of the wire of which it is composed are connected at *E* and *D*. The whole is afterward filled with a pasty carbureted insulating material, *I*.

An apparatus thus constructed gives a spark of which the length may reach from 9 to 10 inches with an expenditure of 6 volts and 4·5 amperes, say about 27 watts.

The inventors have for some time past, without increasing the expense, been manufacturing apparatus that with two coils give a 20 inch spark.



THE WYDTS-ROCHEFORT HIGH TENSION TRANSFORMER.

1. Internal section. 2. View of the exterior. 3. Induced coil.

The insulating paste has very great resistance. No internal silent discharge takes place, whatever be the tension and whatever be the spacing of the terminals. This quality renders the coil of infinite duration and absolutely proof against burning, even if it be submitted to primary currents of exaggerated tension. Let us add that this insulator is non-inflammable and in nowise detonating.

In the interior of Ruhmkorff coils there occurs a series of silent discharges between the induced bobbins, and it often happens that nothing but long, very tenuous, and slender sparks are obtained.

With the transformer under consideration, the phenomena of self-induction are greatly reduced by reason

* "Schools and Universities on the Continent," p. 291.

† "University Education in England, France and Germany," Sir Rowland Blennerhassett, p. 25.

of the feeble extent of the armature. As the spark forms and disappears with great rapidity, it has the quality of that of the static machine. This is a very interesting feature, and the inventors have shown us some tubes which, not having been heated, have lasted for two years.

Messrs. Wydts & Rochefort use for their experiments a rotary mercury interrupter placed upon the condenser.

This new transformer is capable of rendering great services in the production of Roentgen rays and of D'Arsonval currents of great frequency, and even for telegraphy without wires. In fact, Messrs. Wydts & Rochefort have recently been enabled to telegraph without wires to a distance of 11 miles with a transformer giving an 18-inch spark.

For the above particulars and the engraving we are indebted to La Nature.

THE COTTRELL PNEUMATIC TIRE.

A DECIDED departure in pneumatic tire construction will be exhibited at the National Show. This is the Cottrell tire, the new and important feature of which is the means of attaching the cover to the rim. The accompanying engravings will render this new de-

SECTION AND DETAILS OF CYCLE TIRES.

parture intelligible. The rim of the wheel is of an elaborated U section, the flanges being curved in the manner shown, into the recesses of which the incurved headed edges of the cover fit. The edges are secured by annular locking bands of the section shown. These bands are of slightly conical shape, their larger diameters being inward, so that whether the tire be charged or deflated, there is little liability of the cover becoming detached. In fact, it is claimed that, by this conical formation of the rings, jars and vibrations will have a tendency further to secure them. An advantage which is not possessed by any other pneumatic tire to our knowledge is that in case of puncture—for it is not claimed to be puncture proof—no injury will be done to either the tire or rim by riding with the tube de-

SECTION OF MOTOR CAR TIRE.

flated, as the edges of the rim never press on the sides of the tire. The annular recess between the legs of the U can be filled with some suitable material, such as cane or rubber. For motor carriage purposes a circumferential solid rubber cushion of mushroom shape in section, as shown herewith, will be fitted into the central recess, so that in case of puncture there will be no necessity to stop for repairs, as the tire will to all intents become a solid one. A notable advantage claimed for this form of tire is its immunity from side slipping tendencies. The reason of this is that the edges of the cover are securely locked in recesses, which they entirely fill, and, therefore, any lateral pressure greater than that inside the tube—for instance, when the machine has got out of the perpendicular—will not cause the tire to roll in or move apart from the rim. In point of resiliency, the introducers claim that there is no friction on the sides of the Cottrell cover where they touch the rim; consequently, they can be made thinner on the sides than other tires, which have to be strengthened, owing to the chafing action which goes on between the rim and cover. This reduction in thickness makes a more pliant and hence more resilient tire.—Engineer.

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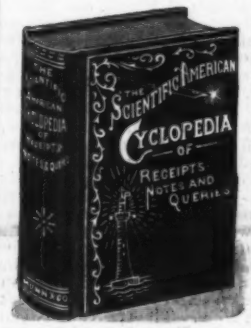

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TABLE OF CONTENTS.

PAGE

I. AUTOCARS.—A School for the Motormen of Electric Carriages in Paris.—1 illustration 19254

II. BICYCLES.—The Cottrell Pneumatic Tire.—4 illustrations 19262

III. BOTANY AND HORTICULTURE.—The Chrysanthemum "What Ho."—1 illustration 19250

IV. CIVIL ENGINEERING.—Rock Blasting under Water.—2 illustrations 19250

V. ELECTRICITY.—The Wydts-Rochefort Transformer.—1 illustration 19261

VI. GLASS.—A Tallow Lamp for Glass Blowing and other Blowpipe Work.—By THOMAS BOLAS.—2 illustrations 19261

VII. MARINE ENGINEERING.—A Problem in Shipbuilding.—3 illustrations 19249

VIII. MEDICINE AND HYGIENE.—Thalassic Submersion a Means for Disposal of our Dead.—By D. LICHT, M.D 19255

IX. MINING ENGINEERING.—The Mining and Minting of Gold and Silver 19251

X. MISCELLANEOUS.—Explosion at the Champeaux Restaurant at Paris.—2 illustrations 19255
Miscellaneous Notes 19257
Engineering Notes 19257
Selected Formulæ 19257

XI. NATURAL HISTORY.—The Elephant in India.—2 illustrations 19259

XII. PHOTOGRAPHY.—The Alethorama.—3 illustrations 19258

XIII. SCIENCE.—A Short History of Scientific Instruction 19250

XIV. TECHNOLOGY.—Cause of Brightness in the Welsbach Mantles 19256

XV. TYPOGRAPHY.—The Cox Typesetting Machine.—5 illustrations 19251

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